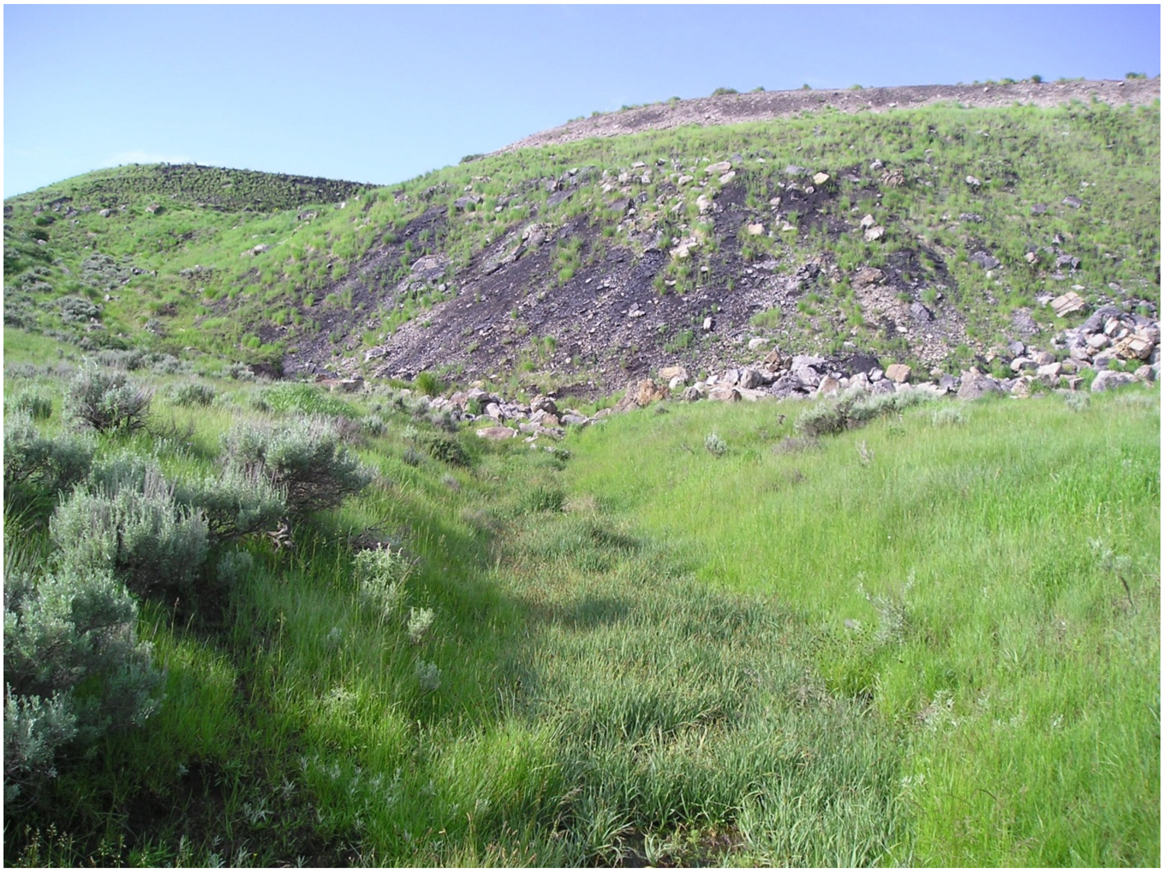

BALLARD MINE
MWD082 SEEPAGE PILOT TREATABILITY STUDY

Test Work Plan and Sampling and Analysis Plan

FINAL – Revision 4

August 2010

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1.0 INTRODUCTION

This *Treatability Test Work Plan and Sampling and Analysis Plan* (*Work Plan*) was prepared by MWH Americas, Inc. (MWH) on behalf of P4 Production, LLC (P4), consistent with the requirements of the Administrative Settlement Agreement and Order on Consent/Consent Order for Remedial Investigation/Feasibility Study (2009 CO/AOC). The 2009 CO/AOC is a voluntary agreement between P4 and the United States Environmental Protection Agency (USEPA), the Idaho Department of Environmental Quality (IDEQ), the United States Department of Agriculture, Forest Service (USFS), the U.S. Department of the Interior (DOI), Bureau of Land Management (BLM), the Shoshone-Bannock Tribes (Tribes), collectively referred to as the "Agencies and Tribes" or A/T. The 2009 CO/AOC is being implemented under the USEPA's Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) authority. This *Work Plan* supports the implementation of a treatability test at one P4's three historic phosphate mines (the Sites) namely the Ballard Mine.

This *Work Plan* presents the project background, objectives, methods, and approach for field testing a selenium treatment process on waste dump seepage at the historic Ballard Mine. The selected treatment process for the test work is biological selenium reduction by anaerobic processes. This treatment process was selected based on the results of testing performed on Horseshoe Overburden seepage at the South Rasmussen Mine (AMEC, 2008), Caribou County, Idaho. Zero valent iron (ZVI) adsorption and biological selenium processes were tested at the South Rasmussen Mine. Biological selenium reduction was selected for the Ballard Mine because this process consistently achieved lower effluent selenium concentrations than the ZVI process and required less hydraulic residence time.

Under CERCLA, onsite treatability studies may be conducted without any Federal, State, or local permits [40 CFR 300.400(e)(1)]. However, such studies must comply with ARARs under Federal and State environmental laws *to the extent practicable* or justify a waiver under CERCLA Section 121(d)(4). CERCLA 121(d)(4)(A) provides that compliance with ARAR requirements may be avoided where the remedial action selected "is only part of a total remedial action that will attain such level or standard of control when completed." The purpose of this pre-ROD treatability investigation is to provide the data needed to develop remedial measures for treating selenium concentrations in waters at the Sites. These measures, if effective, may be included in the remedial alternatives that will be evaluated during the FS process for implementation throughout the Sites. Therefore, as agreed to during our May 11th teleconference, P4 will comply with ARARs during the Treatability Test *to the extent practicable,* but ARARs applying to effluent limitations and other water quality standards to waters discharged from the Treatment Test system will be waived in accordance with CERCLA 121(d)(4)(A). This waiver notwithstanding, if effluent results from discharged waters indicate that the conditions are worse than current conditions (i.e., selenium levels are higher than are currently detected in these waters), then the test would be halted until the situation is resolved.

1.1 BACKGROUND

The Ballard Mine operated from 1952 to 1970, consisting of several side-hill open pits and waste rock dumps. Over the life of the mine, approximately 11 million tons of phosphate rock were mine and trucked to the mining company's elemental phosphate plant near Soda Springs. More than 20 million cubic yards of waste rock were stripped from the mine, with approximately 90 percent of this amount placed in 317 acres of waste dumps and the remaining backfilled into the pits. Many of these waste dumps were partially reclaimed, including experimental plantings by the USFS out of Logan, Utah. Today, the Ballard pits remain largely open (partially backfilled or not backfilled) and waste dump material predominantly exposed and uncovered.

Groundwater seepage flow is associated with several waste dumps at the now inactive Ballard Mine. Among these seepage flows is water emanating at the toe of Waste Rock Dump MWD082 (located on the northeast corner of the mine) and flowing on the ground surface to the property boundary. The flow emanating at the toe of the waste rock dump is intermittent typically running from sometime in April until mid- to late-summer (July to September). The flow occurs primarily during the spring runoff period with a flow duration from three to five months, depending on the precipitation levels for that year. At the highest flows (measured above 100 gpm in early May which likely contained direct snow melt runoff), surface water containing elevated selenium has been observed to leave the mine property. Flow typically diminishes to less than 5 gpm by the end of June. An area of wetness may be present during other periods indicating water in the near subsurface. Even when there is significant flow in this upland ravine during the spring snow melt, it often infiltrates or evaporates before it can potentially reaches a flowing stream.

Monitoring station MST095 is a water quality monitoring location located just downstream of where the seepage emerges at the toe of the waste rock dump. Analytical data from this station is presented in Table 1-1. The flow at MST095 has contained dissolved selenium concentrations as high as 380 μg/L (total concentrations have ranged from 59 up to 446 μg/L). Other analytes that have been characterized as elevated when compared to conservative screening criteria include: i.e., aluminum, barium, boron, and iron (Table 1-1). However, only selenium exceeds the State of Idaho Surface Water Quality for Aquatic Life standards.

Although a clear relationship between the MWD082 seepage and shallow groundwater selenium concentrations has not been verified, installation of a test treatment system may help reduce potential further release of dissolved selenium from this area of the Ballard Mine. It is probable that a portion of the shallow groundwater flow with elevated selenium will be intercepted and seep water that infiltrates to the groundwater system along the drainage channel will be collected and treated. The information produced by the test treatment system proposed in this *Work Plan* will assist in determining effectiveness of this remedial technology and its potential application to address area-wide environmental problems associated with contaminated water.

1.2 SUMMARY OF HORSESHOE OVERBURDEN SEEPAGE TREATABILITY STUDY

A previous water quality treatment study called the Horseshoe Overburden Area Draft Treatability Study was conducted during the 2008 field season. The test work consisted of collection of toe drain seepage, transfer to a nearby holding pond, and controlled feed to both a ZVI system and a bioreactor system. Each test system was operated for approximately three months during the summer of 2008. P4 Production performed the construction and operation of the treatability test systems.

The test systems were designed for flow rates up to 3 gpm with hydraulic residence times of approximately 2 to 3 hours. Feed selenium concentrations were on the order of 150 to 300 μg/L, predominantly present in the oxidized state as selenate (Se^{6+}). Two growth media were tested in the bioreactor, granular activated carbon and plastic attachment media. Also, two different mesh sizes of ZVI were tested in parallel vessels. Both treatment processes were operated in an upflow mode with reactor effluent passed through a sand filter bed to remove particulate selenium.

The performance of both test processes provided mixed results. For the two ZVI vessels, after achieving an initial dissolved selenium removal of 75 to 85 percent, the feed flow rate was decreased by 50 percent (from 3 gpm to 1.5 gpm), resulting in an increased removal rate greater than 99 percent (<5 μg/L). However, after the feed flows were returned to initial rates (approximately 3 gpm), the removal rates in both reactors diminished through the remaining test period. By the end of the test, dissolved effluent selenium concentrations increased to 101 and 138 μg/L, corresponding to removal rates of 20 and 40 percent. Although no detailed explanation was given for the decline in removal rates, it was noted that short circuiting of the media bed may have occurred due to coating of the media with iron precipitates, resulting in increased feed pressures.

For the bioreactors, dissolved selenium removal was pronounced in the granular activated carbon (GAC) media vessels, but less effective in the vessel loaded with plastic attachment media (PAM). Effluent dissolved selenium was consistently less than 5 μg/L for the GAC vessels, indicating high levels of biological activity. For the PAM reactor, dissolved selenium removal was poor initially, but improved over the duration of the test, eventually reaching 55 percent. The lower effluent dissolved selenium concentrations when using GAC suggest that the PAM is not as suitable as GAC for biological selenium reduction.

Throughout the bioreactor testing, significant fouling of pumps, valves, and intra system piping was noted due to biofilms and precipitates. It is likely that this issue was related to high substrate addition rates (molasses and ethanol) as indicated by an average sulfate reduction of 365 mg/L and substantial bicarbonate production. Excess organic carbon addition (that above the amount needed to facilitate selenium reduction) usually results in biological sulfate reduction and is accompanied by decreased sulfate concentrations and conversion of organic carbon to inorganic carbon (net production of bicarbonate). The net product is sulfide which is desirable because it promotes removal of other metals via sulfide precipitation. It is believed that the biological fouling maintenance issue can be managed by controlling the organic carbon addition rate while still producing the necessary amounts of sulfide for removal of secondary metals.

The Horseshoe Overburden seepage treatability study demonstrates the capability of the ZVI and bioreactor processes for selenium removal and provides valuable information for a similar application at the Ballard Mine. It also identifies potential process issues, such as biofouling, that need to be addressed in a treatability test design proposed in this *Work Plan*. Based on the relative performance levels observed in the 2008 treatability tests, it is apparent that selenium reduction through microbially-mediated methods is the more effective process for achieving selenium removal. This conclusion is further supported by the characteristic of seepage at the Ballard Mine which tends to be seasonal, occurring in the spring and summer months when temperatures are highest. Thus, the temperature limitation of a biological system will be reduced, allowing the process to operate consistently at a higher level.

TABLE 1-1
ANALYTICAL DATA FOR MONITORING STATION MST095

Collection Date:	5/14/2004		5/14/2004		5/3/2006		5/3/2006		5/9/2007		5/9/2007		5/15/2008		5/15/2008		5/7/2009		5/7/2009	
	Result	SL	Result	SL	Result	SL	Result	SL	Result	SL	Result	SL	Result	SL	Result	SL	Result	SL	Result	SL
Total Metals (mg/L)																				
Aluminum	NS		NS		NS		NS		NS		<0.03 UK	0.087	NS		0.61 J+K	0.087	NS		NS	
Antimony	NS		NS		NS		NS		NS		NS		NS		0.0005 JK	0.03	NS		NS	
Arsenic	NS		NS		NS		NS		NS		NS		NS		0.0081 K	0.15	NS		NS	
Barium	NS		NS		NS		NS		NS		NS		NS		0.072 K	0.003	NS		NS	
Beryllium	NS		NS		NS		NS		NS		NS		NS		<0.002 UK	0.0006	NS		NS	
Boron	NS		NS		NS		NS		NS		NS		NS		0.03 JK	0.0016	NS		NS	
Cadmium	NS		NS		NS		0.0006 K		NS		NS		NS		0.0005 JK	0.00127	NS		NS	
Chromium	NS		NS		NS		0.0009 K		NS		NS		NS		<0.0003 UK	0.231	NS		NS	
Cobalt	NS		NS		NS		NS		NS		NS		NS		<0.01 UK	0.003	NS		NS	
Copper, total	NS		NS		NS		NS		NS		NS		NS		0.01 JK	0.0371	NS		NS	
Iron	NS		NS		NS		NS		NS		NS		NS		0.46 J+K	0.158	NS		NS	
Lead	NS		NS		NS		NS		NS		NS		NS		<0.0001 UK	0.0109	NS		NS	
Magnesium	NS		NS		NS		NS		NS		NS		NS		35.2 K		NS		NS	
Mercury	NS		NS		NS		NS		NS		NS		NS		<0.0002	0.00077	NS		NS	
Molybdenum	NS		NS		NS		NS		NS		NS		NS		<0.01 UK	0.034	NS		NS	
Nickel	NS		NS		NS		0.0695 K		NS		NS		NS		0.017 K	0.168	NS		NS	
Selenium	NS		0.059	0.005	NS		0.39	0.005	NS		0.073	0.005	NS		0.23 J-	0.005	NS		0.446	0.005
Silver	NS		NS		NS		NS		NS		NS		NS		<0.01 UK	0.00036	NS		NS	
Thallium	NS		NS		NS		NS		NS		NS		NS		<0.0001 UK	0.00003	NS		NS	
Uranium	NS		NS		NS		NS		NS		NS		NS		0.0021 K	0.142	NS		NS	
Vanadium	NS		NS		NS		0.0036 K	0.02	NS		NS		NS		0.0061 K	0.02	NS		NS	
Zinc	NS		NS		NS		0.105 K		NS		NS		NS		0.026 K	0.382	NS		NS	
Dissolved Metals (mg/L)																				
Aluminum	NS		NS		<0.03 UK	0.087	NS		NS		NS		<0.03 UK	0.087	NS		NS		NS	
Antimony	NS		NS		<0.0004 UK	0.03	NS		NS		NS		0.0005 JK	0.03	NS		NS		NS	
Arsenic	NS		NS		0.0008 JK	0.15	NS		NS		NS		0.0068 K	0.15	NS		NS		NS	
Barium	NS		NS		0.047 K	0.003	NS		NS		NS		0.061 K	0.003	NS		NS		NS	
Beryllium	NS		NS		<0.002 UK	0.0006	NS		NS		NS		<0.002 UK	0.0006	NS		NS		NS	
Boron	NS		NS		NS		NS		NS		NS		0.02 JK	0.0016	NS		NS		NS	
Cadmium	0.0002 J-K	0.00127	NS		0.0005 K	0.00127	NS		0.0002 JK	0.00113	NS		0.0004 JK	0.00127	NS		0.000248 J	0.00127	NS	
Chromium	NS		NS		0.003 K	0.231	NS		<0.0001 UK	0.197	NS		<0.0001 UK	0.231	NS		NS		NS	
Cobalt	NS		NS		<0.01 UK	0.003	NS		NS		NS		<0.01 UK	0.003	NS		NS		NS	
Copper	NS		NS		<0.01 UK	0.0371	NS		NS		NS		<0.01 UK	0.0371	NS		NS		NS	
Iron	NS		NS		<0.02 UK	0.158	NS		NS		NS		<0.02 UK	0.158	NS		<0.0250	0.158	NS	
Lead	NS		NS		<0.0001 UK	0.0109	NS		NS		NS		<0.0001 UK	0.0109	NS		NS		NS	
Magnesium	38.9 J-K		NS		49.4 K		NS		21.6 K		NS		34.3 K		NS		38.3		NS	
Mercury	NS		NS		<0.0002	0.00077	NS		NS		NS		<0.0002	0.00077	NS		NS		NS	
Molybdenum	NS		NS		0.01 JK	0.034	NS		NS		NS		<0.01 UK	0.034	NS		NS		NS	
Nickel	0.0068 J-K	0.168	NS		0.0665 K	0.168	NS		0.0108 K	0.142	NS		0.0167 K	0.168	NS		NS		NS	
Selenium	NS		NS		0.38	0.005	NS		NS		NS		0.25	0.005	NS		NS		NS	
Silver	NS		NS		<0.01 UK	0.00036	NS		NS		NS		<0.01 UK	0.00036	NS		NS		NS	
Thallium	NS		NS		<0.0001 UK	0.00003	NS		NS		NS		<0.0001 UK	0.00003	NS		NS		NS	
Uranium	NS		NS		0.0062 K	0.142	NS		0.0013 K	0.142	NS		0.0019 K	0.142	NS		NS		NS	
Vanadium	0.0023 J-K	0.02	NS		0.0013 K	0.02	NS		0.0058 K	0.02	NS		0.0058 K	0.02	NS		<0.00500	0.02	NS	
Zinc	0.013 J-K	0.382	NS		0.101 K	0.382	NS		0.013 K	0.324	NS		0.023 K	0.382	NS		NS		NS	

Notes:
NS - not sampled
SL - screening level

Result is greater than screening value
Method detection limit for non-detected value is greater than the screening value

Flag Definition:
U The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J The result is an estimated quantity. The associated numerical value is the approximated concentration of the analyte in the sample.
J+ The result is an estimated quantity, but the result may be biased high.
J- The result is an estimated quantity, but the result may be biased low.
J+/B Result is estimated and biased high; associated field blank contained target analyte.
R The result is unusable. The sample result is rejected due to serious deficiencies in meeting quality control criteria. The analyte may or may not be present in the sample.
UJ The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
K Serial dilutions not performed for samples analyzed by this method (EPA 200.7; 200.8).

Sources for Screening Values:
Unless identified otherwise below, screening levels are the chronic freshwater screening value in NOAA SQuiRT (Buchman, 2008).
Screening levels for aluminum is the Freshwater Standards for Chronic Criteria (CCC) from the National Recommended Water Quality Criteria (USEPA, 2009).
Screening values for arsenic, cadmium, chromium, copper, lead, nickel, selenium, and zinc are the CCCs from the State of Idaho Surface Water Quality for Aquatic Life (IDAPA 58.01.02); those for cadmium, chromium, copper, lead, nickel, and zinc are expressed as a function of total hardness. Screening levels for cadmium and selenium are expressed as total recoverable (unfiltered concentration).
The screening level for iron is the Lowest Chronic Value (LCV) observed for fresh water daphnids (source: ORNL, 1996).
The screening levels for manganese, uranium, and vanadium are the Tier II Secondary Chronic Values (source: ORNL, 1996).

2.0 PROJECT OBJECTIVES

This treatability study is proposed to provide valuable information that supports the development and evaluation of remedial technologies and alternatives in the feasibility study (FS) of the CERCLA process. The pilot treatability study presented in this *Work Plan* will yield data that are essential in determining the performance efficiency of the selected process. Secondarily, this pilot will help to establish design criteria for larger, full-scale systems specifically utilizing Ballard Mine seepage. The principal objectives of the study are to establish the level(s) of selenium removal that can be achieved and the reliability of the process in achieving effluent targets so that the treatment technology and design can be properly considered during the FS.

As with any well designed treatability study, the testing will define process limitations as they pertain to performance, operational variability, and maintenance issues. It is anticipated that the testing will be performed over at least two high-flow seasons to allow for interim adjustments and modifications to the overall process. The high-flow season at the Ballard Mine occurs from April to July, over a period in which selenium loading to the water that will be treated is highly variable, thus allowing assessment of changing operating conditions.

This *Work Plan* describes the physical system components, including the collection system, reactor vessels, and filtration bed, which will comprise the selenium removal process. In addition, the Sampling and Analysis Plan (SAP) details the procedures for water collection, handling, analysis, and quality assurance. An outline of the operating plan is also provided in Section 6 to establish the methods for achieving the test objectives.

A biological process for selenium reduction is selected for reasons stated in Section 1.2 of this *Work Plan*. The MWD082 seepage location is selected because it represents one of the highest potential selenium loads in the area affected by the Ballard Mine wastes and is in an area of known elevated shallow groundwater selenium concentrations that extends off the Ballard Mine site. Therefore, this seep provides a secondary benefit of reducing the mass of selenium potentially released to the Wooley Valley drainage system. The specific challenges of this location are its relative remoteness and related physical access limitation, small available working area, and lack of a nearby power supply.

The primary objectives of the *Work Plan* for biological selenium reduction are to establish that:

- The treatment system removes selenium consistently from the seepage discharge at flow rates and chemistry typical of the Ballard Mine and other Sites included in the RI/FS
- The effluent selenium concentrations that can be reasonably achieved, targeting a concentration below 5 μg/L
- The effluent does not have any other characteristics that would inhibit discharge to aquatic habitat (the most conservative scenario)
- The toxicity characteristics of treatment residuals and process materials

Secondarily performance data also will be collected so that future modifications to this or other systems construction can be optimized. These data also may be used in the FS process related to system cost or reliability, for example. Some of the secondary objectives for this pilot test are:

- Determine the appropriate method of bacterial inoculation, focusing on native bacterial communities in the stream sediments in the specific area and, if necessary, considering strain-specific inoculation to enhance process performance
- Establish selenium removal rates by evaluating the relationship between residence time in the bioreactor and effluent dissolved selenium concentrations.
- Determine the optimum growth media for balancing performance and hydraulic maintenance
- Establish startup requirements
- Determine relationship between organic carbon substrate addition rates and selenium removal
- Confirm the need for particulate selenium removal from the bioreactor effluent. In addition, dissolved oxygen (DO), biochemical oxygen demand (BOD), total suspended solids (TSS), pH, cadmium, iron, manganese, nickel, zinc, dissolved organic carbon, nitrate, ammonia, sulfate, and total phosphorous will be monitored as potential “deleterious” substances

3.0 PROCESS DESCRIPTION

Biological selenium reduction relies on microbially-mediated reduction and oxidation (redox) chemistry. The microbial activity is typically stimulated by the addition of a relatively simple organic carbon source (substrate) such as soluble alcohols and/or sugars. A goal of the biological process is to lower the redox condition to a state that promotes changes in the target substance. In this case, the goal will be to reduce selenium from its oxidized state (Se^{4+} or Se^{6+}) to a relatively insoluble elemental state (Se^{0}). Typically, the redox state decreases as the microbial activity rate increases, an operating parameter that can be controlled to a certain degree by substrate addition rates. Selenium, because it exists in relatively small quantities, usually does not require large substrate concentrations. Excess substrate addition, that which is above that needed for selenium reduction, will likely result in sulfate reduction and subsequent production of soluble sulfide. A goal of this test will be to limit and control the amount of sulfide produced to only the amount needed to facilitate removal of other metals (e.g., nickel, zinc).

Numerous studies and test applications for selenium treatment are documented in the literature (USEPA, 2001). A biological process is appropriate for selenium removal at the Ballard Mine, because the site is remote and has no available line power. The process operates with limited maintenance inputs and usually requires minimal bed replacements as the substrate can be fed in the form of soluble liquid. This is contrasted with fixed bed adsorption media that requires replacement as the capacity becomes exhausted.

As described previously, the Horseshoe Overburden seepage treatability tests provide a valuable baseline for this test application. The results from these tests demonstrate the potential performance of this technology in addition to identifying preliminary design parameters and operational limitations. The information developed in the Horseshoe Overburden seepage testing serves as the basis for the test process design. The process will be refined at the Ballard Mine using the specific water chemistry produced from the older, possibly more geochemically evolved, mine waste dumps.

4.0 TEST DESIGN

The treatability test system is designed to operate on the total seepage flow from MWD082 (a maximum of approximately 30 gpm). Initially, flows greater than 30 gpm will be diverted, bypassing the test system. It will evaluate the ability of the process to handle this full-scale flow as well as variable flows as seepage rates diminish during the late spring and into early summer. Total seepage flow will be monitored by a v-notch weir and pressure transducer installed by P4 at the toe and an inline flow meter to the test process. The pumped influent to the test process will be continuously monitored for instantaneous and totalized flow by a battery-powered in-pipe instrument. The combined flow measurements will provide the total seepage flow.

The test system will be operated for two years (spring seasons) to allow first season operating data to be reviewed and adjustments made for the second season, thus allowing operational limitations to be identified and appropriated modifications implemented. Appropriate modifications may entail a determination that a particular media blend provides better performance and should be installed in all three bioreactor tanks for second season testing. The test may be extended for further seasons depending on the results and need for additional data, and the status of the overall project at the Ballard Mine.

Seepage will be collected in a small pond behind the v-notch weir recently installed at the toe of MWD082. The ponded water will then be pumped to an elevated location from where it will flow through the system by gravity. After pumping the seepage to the elevated location, approximately fifteen feet of elevation change will be available to facilitate gravity flow through the downstream treatment units. Thus, careful placement of tanks and interconnecting piping will be important to ensure adequate hydraulic capacity for the higher flows.

4.1 DESIGN MEASURES TO ADDRESS POTENTIAL BIOFOULING

A principal limitation to fixed bed bioreactors is the loss of hydraulic capacity due to the accumulation of precipitated compounds and biomass. Several measures will be employed in the test system design and operation to help ensure that adequate flow capacity is maintained throughout the test duration, including:

- Installation of oversized piping
- Distribution/collection manifold configurations that are conducive to effective cleaning
- Limited substrate (organic carbon) feed rates to control biological overgrowth
- Pipe flushing capability with the initial circulation pump
- Utilization of various growth media blends that incorporate coarser materials and larger void spaces
- Capability of pulsing the bed with a higher flow rate to flush excess bacterial growth from the influent distribution piping and gravel

Although Figures 1 and 2 provide conceptual piping locations and orientation, the actual piping configurations will be developed in detail during the design phase of the project with input from P4 regarding maintenance and operational control features. It is also noted that one of the primary objectives of the test work is to define the hydraulic limitations of the fixed bed process and to develop methods for maintaining operational capacity over longer periods.

4.2 TEST SYSTEM DESCRIPTION

Seepage will be collected at or near the point where flowing water is present just below the MWD082 location. As discussed previously, a v-notch weir and small pond (less than 4 feet deep) will be installed to allow efficient capture of this seepage flow and to minimize surface inputs from upgradient slopes and the unnamed drainage located to the southeast. Since the test system will operate only during the warm season, it will not be necessary to bury the collection structure. Bypass piping will be installed to facilitate flow control and maintenance activities as they become necessary. Figures 1 and 2 provide a layout and profile view of the planned test system components.

Water from the collection structure will be pumped approximately 100 feet west/northwest up the slope of the drainage in 2-inch plastic pipe to a carbon dosing tank. The pumped water flow rate will be controlled by an adjustable, automatic flow control valve placed in the pipe delivering water to the carbon dosing tank. Power for all test pumping will be supplied by battery storage and/or solar panels.

The carbon dosing tank will serve as the location where (1) liquid organic carbon substrate is added to the seepage flow and (2) gravity flow through the test system begins. Flow rate monitoring will occur immediately upstream of this tank to assist in controlling the liquid organic carbon dose rate. The flow monitoring device will be battery powered and possess the capability of controlling the carbon dosing system via a low amperage output signal. The carbon dosing tank will also provide a means for collecting sediment that may be transported from the collection structure, thus protecting downstream tank piping from potential clogging. A bypass line (bypassing the carbon dose tank) will be installed to address potential biofouling in the carbon dose tank and downstream piping to the bioreactors.

Liquid organic carbon will be added in the same form as that used for the Horseshoe Overburden study, comprised of a blend of sugar (e.g., glucose) and alcohol (e.g., ethanol). The liquid will be stored in a standard 500-gallon storage tank near the carbon dosing tank. The storage tank will be partially filled approximately twice per month (bi-monthly) to ensure that the liquid organic carbon mixture is fresh (i.e., it hasn't degraded)._ The soluble liquid organic carbon likely will be fed at a rate between 1 and 10 mL per minute with the actual rate depending on the seepage flow rate and target concentration. The target organic carbon concentration will be based on achieving a limited amount of sulfate reduction and sulfide production.

Three parallel biological treatment cells will be installed approximately 100 feet down gradient of the carbon dose tank. These cells will be identical pre-cast concrete tanks having approximate dimensions of 20 feet in length, 8 feet in width, and 4 feet in depth. The cells will be loaded with growth media comprised of pelletized activated carbon (GAC; typical particle size of 4 mm) and pebble limestone ($CaCO_3$ approximately 3/8-inch) and include a 8-inch layer of inert gravel base to distribute influent flows. Limestone is included in the growth media blend because results from the Horseshoe Overburden Area Treatability Study indicate lower effluent pH, suggesting the need for alkalinity addition to maintain neutral pH conditions. Different blends of the growth media will be installed in each of the three cells. The blend ratio and particle size of the GAC/limestone growth media will be based on optimizing pore volume (for residence time and hydraulic capacity) and surface area (for bacteria density). A total volume of 560 cubic feet will be installed in each treatment cell.

System inoculation will be accomplished by placing approximately 5 cubic feet of nearby streambed sediment on the top surface of the growth media beds. This material will be distributed across the surface of the growth media then rinsed down into the bed with the aid of a small pump. MWD082 seepage will serve as the rinse solution.

Treated effluent from the biological treatment cells will be collected into a common 6-inch header and conveyed to a sand filter bed located approximately 20 feet down gradient of the last treatment cell. The sand filter bed will be used to remove and collect selenium particulate and detached microorganisms before discharge. The plumbing in the filter will allow influent to bypass the sand media if the bed surface is blinded or experiences an upset. Blinding occurs when a layer of solid particulates form on the outer or upper surface of a filter media and causes rapid degradation of hydraulic application rates, or leads to excessive head build up.

Periodic monitoring and bed maintenance will be performed to help ensure flow is maintained through the sand media. Sand filter monitoring will consist of recording fluid level measurements in the tank. Bed maintenance will consist of washing or mechanically cleaning the top surface of the sand. The criteria for bed maintenance will be a field decision based on observation of bed conditions and the rate of fluid level increase in the tank. Based on a filter surface area of 160 square feet (8’ x 20’), the filtration rate will range from approximately 0.02 to 0.2 gpm per square foot. Operating data from the Horseshoe Overburden testing indicated very low particulate selenium concentrations and relative low total suspended solids in the bioreactor effluent streams.

4.3 SYSTEM CONSTRUCTION

Test system installation will be conducted by P4. Material specification, sizing, and system design will be overseen by an engineering consultant to P4. Construction oversight and as-built information will also be provided by an engineering consultant to P4.

Because of space limitations and the lack of elevation drop in the test location, excavation may be required for tank installations. It is possible that the required base elevations of the excavations will encounter wet soil of shallow groundwater. Thus, dewatering, compaction, and/or installing a drainage pad may be required under the treatment tanks to provide a stable foundation. This action will protect interconnecting piping and help ensure that unacceptable settling does not occur.

Pipe cleanouts will be located at the influent and effluent ends of each treatment unit. Weekly to semi-weekly cleaning of system piping will be conducted through these cleanouts to minimize operational interruptions due to bio-fouling. Piping and cleanout configurations will be designed to ensure that adequate hydraulic capabilities are maintained throughout the test duration.

4.4 PROCESS OPERATION

The test operation will commence by filling the three biological treatment cells with MWD082 seepage. It is estimated that approximately three hours will be needed to complete the tank fill. Liquid organic carbon initially will be added at a higher concentration than planned for continuous operation; this concentration will likely be in the 50 to 200 mg/L range, depending on the type of liquid organic carbon solution that is used. The liquid organic carbon will be added during the entire fill time at this initial rate to help ensure adequate dispersion through the biological treatment cells.

After filling is complete, treatment cell effluent will be collected and recirculated to the carbon dosing tank; additional liquid organic carbon will not be added during the circulation. Three pore volumes will be recirculated through the treatment cells for approximately 5 hours at a rate of 50 gpm. Recirculation will be accomplished with portable power generation, a sump pump installed in a temporary collection tank, and a 2-inch flexible hose.

After the initial recirculation, the pump power will be disconnected and treatment cell fluids will begin a “static” growth state for days two and three. On day four, the fluids will be recirculated for three more pore volumes to distribute the microbial community that begins to develop. A measurement of total dissolved organic carbon will be made after the first pore volume is recirculated to determine if additional liquid organic carbon should be added to the last pore volume. After three pore volumes are completed, two more days of static growth will be provided. This cycle of one day recirculation (3 pore volumes) and two days of growth will be repeated three to four times, depending on the evidence of anaerobic microbial activity (field ORP measurements). Field monitoring of ORP and organic carbon will provide an indication of growth progress and if adjustments (i.e., increased or decreased recirculation volume) are needed during this phase of the study.

After adequate microbial activity is observed, the treatment test system will be placed in operation at the design flow rate (30 gpm). Liquid organic carbon will be delivered to the carbon dosing tank to attain the test target concentration. If water from the seep is flowing above the design flow rate, that fraction will be diverted around the system before it reaches the carbon dosing tank. As the collected seepage flow decreases to 30 gpm and below, the entire seep flow will be routed to the test system. During that time, the liquid organic carbon dose rates will be adjusted to maintain the test target concentration for lower flow rates.

When the seepage flow rate decreases to 20 gpm, the least effective treatment cell will be removed from operation (as determined through routine testing). Reducing the number of treatment cells to two at this point will help maintain the test target hydraulic retention time. When the seepage flow decreases to 10 gpm, again the least effective treatment cell will be removed from operation. The final portion of the treatability testing will be completed using the most effective treatment cell. Treatment cell performance will be evaluated based on dissolved effluent selenium concentration because selenium removal in the bioreactor cells primarily occurs when soluble selenium is converted insoluble selenium through microbially-mediated reactions. It should be noted, however, that effluent measurements in the bioreactor will include both total recoverable and dissolved selenium analyses.

In the event that dissolved effluent selenium concentrations are below detection for all cells, effluent sulfate, nickel, zinc, and ORP will be used to rank treatment cell performance. It is expected that sulfate reduction will occur (to a limited degree) in the bioreactors and thus produce soluble sulfide that is available to react with metals that may be present in the influent.

Sulfate reduction indicates a greater level of microbial activity and thus more favorable conditions for biologically-mediated removal of contaminants. Nickel and zinc are included because these have been observed at levels above detection in the flow from MWD082 at MST095 and they are indicators of metal-sulfide precipitation. If effluent dissolved selenium concentrations are above 5 μg/L in all treatment cells, then each cell will remain in operation until this target concentration is achieved or flow decreases to less than 5 gpm for each treatment cell.

4.5 TEST MONITORING

Test system monitoring during the initial recirculation and growth period will consist of field parameter measurement collected at the beginning and ending of each recirculation. The principal measurements will be pH, temperature, dissolved oxygen, and ORP, with possible augmentation of field sulfate and alkalinity measurements if the principal parameters are not sufficiently indicative of the level of anaerobic activity. Sulfate and alkalinity would be indirect indicators of biological activity as sulfate is reduced to sulfide and organic carbon is converted to carbonate.

Test system monitoring during the primary operational period will consist of sample collection for certified laboratory analysis. The parameters analyzed will include major ions, metals, DOC, TDS, TSS, BOD, and nutrients. A complete list of analytes, sampling locations, sampling frequency, and related procedures is provided in Section 6.

4.6 END OF SEASON TEST SHUT DOWN

The seasonal pilot treatability testing will be considered complete when MWD082 seepage decreases to less than 1 gpm. At that time, seepage will be diverted from the test system and allowed to flow into the natural drainage channel. Test system piping and tanks will be drained to protect from winter conditions. The carbon feed pump and flow indicators will be removed from the process and stored for use in the next test season.

Depending on the initial test season results, growth media may be replaced in the biological treatment cells after test shut down. Media replacement will help ensure that all treatment cells contain the best performing blend of GAC and pebble limestone for testing in the second season. Media that is removed from any cell will be tested using appropriate methods for toxicity characterization (e.g., TCLP) then disposed of in a manner that is compliant with the characterization results and local, State and Federal regulations.

4.7 DISCHARGE PERMITING

This test will be conducted as part of the 2009 CO/AOC between P4 and the A/T. This project is in compliance with CERCLA, and it is anticipated that the discharge from this treatability testing will not need a NPDES or State discharge permit, IDWR Dam Permit, or Stream Alteration Permit. If it were determined that permit is required, it would likely not be possible to conduct this treatability test in support of the RI/FS process this year. Regardless, all substantive requirements of applicable Federal and State regulations will be followed consistent with CERCLA.

5.0 DATA QUALITY OBJECTIVES

The following data types and data quality are needed to support the evaluation of the treatability test process effectiveness. These data objectives are consistent with the EPA guidance for Conducting Treatability Studies under CERCLA (USEPA, 2006).

5.1 PROBLEM STATEMENT

Selenium concentrations in MWD082 seepage waters exceed 300 μg/L, which is elevated with respect to the surface water quality standard of 5 μg/L. Although the capability of biological selenium reduction was demonstrated for the Horseshoe Overburden seepage at a flow of 3 gpm, this technology needs to be tested at higher flows and for longer operating periods. Thus, a full-scale treatability study is proposed for selenium removal in waters collected from the MWD082 seep.

5.2 STUDY GOAL

The general goal of the study is to establish the feasibility and overall effectiveness at meeting the selenium surface water quality standard for this stream and potentially other waters specific to the inactive Ballard Mine site. Specific performance parameters and other relevant data will be developed to allow for the technology to be evaluated during the pending technology and remedial alternative analysis in FS for the Ballard Mine. In addition, data collected during the treatability test study will be used by P4 to develop and evaluate remedial actions that address elevated surface water selenium concentrations in other areas of their mining operation. The results from this study may indicate a feasible application of the biological selenium reduction technology for this and other areas at the inactive Ballard Mine.

The specific principal study questions are as follows:

Principal Study Question #1

Will the treatment system reduce selenium concentrations in selenium impacted seepage discharges?

Alternative Actions:

1. The treatment system is capable of reducing selenium concentrations sufficiently to be considered a viable water treatment technology in the FS, and potentially be part of the remedy for the Sites.
2. The treatment system is not capable or is ineffective at reducing selenium in seepage water to needed levels and should be dropped from consideration during the FS.

Principal Study Question #2

Can the treatment system achieve a water quality sufficient to meet the most conservative potentially applicable water quality standard for selenium (i.e., the aquatic water quality standard of 5 μg/L)?

Alternative Actions:

1. The treatment system demonstrates a high level of effectiveness and may produce an effluent suitable for direct discharge to aquatic habitat, and therefore, should be considered a fully viable treatment technology in the FS.
2. The treatment technology and system may be limited at locations where the discharge needs to attain conservative standards because of poor selenium removal performance (e.g., the aquatic life standards for selenium in water). Therefore, this technology and system design may have limited applications in the FS.

Principal Study Question #3

Are the physical and chemical characteristics of the test process effluent suitable for discharge to streams that support cold-water aquatic biota and aquatic-life habitat?

Alternative Actions:

1. The treatment system effluent does not introduce any detrimental physical or chemical characteristics to the effluent, and removes sufficient levels of other COPCs (e.g., cadmium) so that the discharge meets the aquatic life standards, and therefore, the technology and treatment system design should be considered a viable alternative during the FS evaluations of water treatment technologies.
2. The treatment system effluent has physical or chemical characteristics that may require further treatment before discharge to aquatic habitat, or has characteristics that may limit it use and consideration during the FS evaluations, as discussed above.

Principal Study Question #4

What is the volume and toxicity characteristic (TCLP) of any waste (i.e., growth media, spent sand) generated by the process?

Alternative Actions:

1. The waste generated by the system is not hazardous and disposal of the spent media is not problematic, and these waste product characteristics will be considered in the FS.
2. The system generates hazardous wastes and the handling and disposal costs associated with these materials would be considered in the FS evaluation.

5.3 INFORMATION INPUTS

To monitor the system performance and effectiveness the following data will be collected:

Principal Study Question #1

- Influent (and effluent) selenium concentration collected on a periodic basis to assess of the range of selenium concentrations that can be treated using this system..

Principal Study Question #2

- Effluent selenium concentrations collected on a periodic basis to assess consistency of treatment.

Principal Study Question #3

- Effluent chemistry from each of the operating cells for metals, major elements, nutrients, and bulk parameters such as dissolved oxygen, oxidation-reduction potential, and pH.

Principal Study Question #4

- Analysis of the system wastes using the Toxic Characteristic Leaching Procedure (TCLP) to evaluate if the wastes generated are hazardous (i.e., exhibiting the characteristic of toxicity).

In addition to the data collect to answer the principal study questions, other data and input will be assessed to document and optimize system performance. These include:

- Growth media mass, surface area, and porosity (determined from material grain size);
- Seepage water flow rate and volume through the system;
- Substrate addition, rate and volume;
- Changes in tank water levels, indicating loss of hydraulic capacity.

5.4 STUDY BOUNDARIES

The treatability test will be implemented at and downstream of the current seep location at the base of Ballard Mine waste rock dump MWD082, which is upstream of stream monitoring station MST095. This location and treatment system space requirements are shown on Figure 1.

The duration of the test will be from the spring through the summer of 2010 and 2011. The test will begin each season as soon as temperatures are warm enough for system construction and operation and conclude when the seep flow drops below 1 gpm. The test may be extended beyond 2011, if further data collection is indicated by the test results. However, at this time there is not a specific plan to make the test treatment system part of the permanent remedy for the Site. The determination to do that would be dependent upon the outcome of the RI, human and ecological risk assessments, and FS. At most, the pilot system might be considered an interim action prior to the FS should the human and ecological risk assessments indicate that the water at this location presents a risk. This pilot test system would require substantial modification to become a permanent installation.

Data collection may be limited during periods of adverse weather such as snow fall or heavy rain. No other limitations on the ability to collect data or monitor the system are foreseen.

5.5 ANALYTIC APPROACH

A treatability test of MWD082 seepage for selenium removal will determine the effectiveness of this technology. Several decision inputs and decision rules apply.

Decision Input 1: *Are test effluent concentrations less than test influent concentrations and what is the level of reduction obtained?*
Decision Rule 1: A decrease in effluent concentrations relative to influent concentrations indicates that the process is effective. An increase or lack of change in selenium concentrations indicates that the process is ineffective for selenium removal. The percentage of reduction is an indication of system performance.

Decision Input 2: *Are test effluent selenium concentrations less than 5 μg/L?*
Decision Rule 2: Test effluent selenium concentrations below 5 μg/L indicate that the process is effective for meeting the State of Idaho's surface water standard for selenium. Test effluent selenium concentrations above 5 μg/L indicate the process is ineffective for meeting the standard.

Decision Input 3: *Are the physical and chemical characteristics of the test process effluent suitable for discharge to streams that support cold-water aquatic biota and aquatic-life habitat?*
Decision Rule 3: Test effluent monitoring of the physical and chemical characteristics will be monitored to determine potential detrimental effects to cold-water aquatic habitat that may be applicable at some locations where this treatment method would be utilized. If determined to potentially detrimental, additional evaluation of the process's applicability for surface water discharge will be conducted. The parameters to be specifically monitored for this evaluation include:

- DO, BOD, TSS, pH, cadmium, iron, manganese, nickel, zinc, dissolved organic carbon, nitrate, ammonia, sulfate, and total phosphorous. Section 6 provides specific information related to this analytes and associate water quality criteria. In addition, the physical appearance and odor of the discharge will be noted.

Decision Input 4: *What is the volume and toxicity characteristic (TCLP) of any waste (i.e., growth media, spent sand) generated by the process?*
Decision Rule 4: TCLP testing of the growth media and spent sand will be the determinant for evaluating hazard characteristics.

5.6 PERFORMANCE OR ACCEPTANCE CRITERIA

Treatability test study data will be applied to the four decision rules, which in turn will be tested against a null hypothesis and alternate hypothesis. The null hypothesis will be tested by statistical methods that allow decisions to be made at a known confidence level, if appropriate. Statistics will be primarily descriptive (e.g., average, media, min-max, standard deviation). However, confidence levels will be calculated and utilized if appropriate. Because the system may be run at a variety of conditions and not all data will be comparable, some hypothesis testing may have to be judgmental or based on subsets of data. Flexibility will be required in the assessment of the data, but an attempt to statistically quantify the data will be made. When a null hypothesis is deemed incorrect, an alternate hypothesis will be accepted in its place.

Principal Study Question #1:

Null hypothesis 1: The test process does not effectively remove selenium from seepage water as indicated by statistical and graphical measures of average concentrations by operational period and plots of influent and effluent concentrations. Removal efficiency will be similarly calculated.

Alternative hypothesis 1: The test process effectively removes selenium from seepage water.

Types of Decision Errors: *A type 1 error is a false rejection error that rejects the null hypothesis when it is actually true. A type 1 error indicates that the test process is effective when it is actually ineffective.*

A type 2 error is a false acceptance error that states the opposite of the null hypothesis, indicating that the test process is ineffective for reducing selenium concentrations when it actually is effective. A type 2 error will result in an incorrect rejection of the test process when it is actually effective for selenium removal.

Professional judgment will be utilized to assess the decision error unless differences are small enough that the differences can only be resolved by statistical analysis. However, should such analysis be required, it would likely indicated that the removal efficiency is not adequate given the cost of treatment. This evaluation would be conducted during in the FS. The number of samples collected and analyzed will be sufficient to test the null hypotheses at acceptable error rates and confidence levels. A 95-percent confidence level will be applied to the statistical analysis of the test process influent and effluent selenium concentrations for appropriate portions of the data (e.g., interval with consistent operating conditions).

Principal Study Question #2:

Null hypothesis 2: The test process does not effectively achieve the 5 μg/L selenium standard.

Alternative hypothesis 2: The test process effectively achieves the 5 μg/L selenium standard.

Types of Decision Errors: *A type 1 error incorrectly indicates that the test process achieves the standard. A type 2 error incorrectly indicates the test process does not achieve the standard.*

The data developed will allow for an assessment of the consistency of the achieving the concentration goal(s). The error will need to be assessed judgmentally to factor in system upsets or changes in operation. The adherence to the QAPP and QAPP Addenda will help ensure the data are of appropriate quality and detection limits are suitable for the evaluation. The number of samples collected and analyzed will be sufficient to test the null hypotheses at acceptable error rates and confidence levels. A 95-percent confidence level will be applied to the statistical analysis of the test process influent and effluent selenium concentrations for appropriate portions of the data (e.g., interval with consistent operating conditions.

Principal Study Question #3:

Null hypothesis 3: The physical and chemical characteristics of the test process effluent are potentially detrimental to aquatic life in the receiving stream.

Alternative hypothesis 3: The physical and chemical characteristics of the test process effluent are not potentially detrimental to aquatic life in the receiving stream as indicated by comparison to relevant and applicable water quality standards that may apply at some locations at the Site.

Types of Decision Errors: *A type 1 error incorrectly indicates potentially detrimental effects, whereas a type 2 error incorrectly indicates that the effluent is not detrimental.*

Principal Study Question #4

Null hypothesis 4: The test process produces hazardous waste.

Alternative hypothesis 4: The test process does not produce hazardous waste.

Types of Decision Errors: *A type 1 error incorrectly indicates that the waste is not hazardous, whereas a type 2 error incorrectly indicates that the waste is hazardous.*

For hypothesis 3, test process effluent physical and chemical characteristics will be compared to potential receiving streams aquatic life to determine if changes will occur, and the effects that may result. Hypothesis 4 will be tested by comparison of TCLP results of potential test process wastes to regulatory criteria for hazardous designation.

5.7 PLAN FOR OBTAINING DATA

To collect the data needed to test the hypotheses, sampling and analysis will be required of the influent and effluent streams for key parameters that best indicate performance of the system. These parameters and methods are presented in Section 6.2 and 6.7, respectively. In addition, data indicating the ability to discharge the effluent to surface water of the State of Idaho will be needed and well as for determining the hazardous characteristics of the growth media for disposal. A plan is presented in the Section 6 for obtaining these data. In general, data will be collected at appropriate frequencies for evaluating the system performance and may be adjusted based on flow rate and stage of the treatability test. Sample collection frequency adjustments may be made to compensate for expected decreases in the influent flow rate (i.e., high in the spring to low in the late summer and fall), as well as increased application rates that are designed to test the process response to decreased hydraulic retention time.

Only those field measurements and laboratory results that meet acceptable accuracy and precision criteria will be utilized for testing the null hypotheses. Laboratory analytical test methods that are EPA approved and have appropriate detection limits (e.g., below applicable standards) will be applied to all test samples. Standard sample collection, preparation, and handling procedures will minimize measurement errors outside of the analytical laboratory control.

For other physical data, the data will be collected as follows:

- Growth media mass, surface area, and porosity will be determined from material grain size information supplied by the manufacturer;
- Seepage water flow rate and volume through the system will be determined by automated flow rate monitoring and totalizing;

- Substrate addition, rate and volume will be determined by automated flow rate monitoring and totalizing; and

- Changes in tank water levels, indicating loss of hydraulic capacity will be determined by manual measurements collected during water quality monitoring.

6.0 SAMPLING AND ANALYSIS PLAN

The sampling and analysis plan provides details regarding sample locations, frequency, procedures, analyses, and data handling. All sample collection and analytical methods will comply with established procedures and protocols specified in the *Quality Assurance Project Plan* (*QAPP*; MWH, 2004), subsequent addendum (MWH, 2009b) and EPA's *Guidance for Quality Assurance Project Plans* (EPA, 2002). A tabulated summary of the samples to be collected and field and/or laboratory testing parameters is provided as Attachment A.

6.1 INITIAL TEST RECIRCULATION AND GROWTH PERIOD

During the test recirculation and growth period, the principal analysis will be field measurements of pH, temperature, specific conductance, dissolved oxygen, and ORP, with possible augmentation of field sulfate and alkalinity measurements (indicators of sulfate reduction and inorganic carbon generation). These measurements will be made at the beginning and end of each recirculation period, collected at the combined effluent end of the biological treatment cells. Water samples for laboratory analyses will not be necessary or collected during this initial phase of the treatability test.

6.2 PRIMARY TEST OPERATIONAL PERIODS

After the initial test recirculation and growth period is complete, the primary test operation will commence. During the primary test operation, samples will be collected at four locations:

- Influent side of the Carbon Dosing Tank
- Individual effluent side of the Biological Treatment Cells
- Combined effluent side of the Biological Treatment Cells
- Effluent side of the Sand Media Filter.

Water samples will be collected at these locations on a weekly basis for the following measurements and analyses:

- Field measurement of pH, temperature, specific conductance, dissolved oxygen, and ORP
- Laboratory analysis of dissolved major elements, calcium, magnesium, potassium, sodium, sulfate, chloride, fluoride, and bicarbonate
- Laboratory analysis of dissolved metals, cadmium, nickel, and zinc
- Laboratory analysis of dissolved and total selenium and arsenic
- Laboratory analysis of dissolved nutrients, dissolved organic carbon, nitrate-nitrogen, ammonia-nitrogen, and phosphorous
- Laboratory analysis of total dissolved solids (TDS) and total suspended solids (TSS)
- Laboratory analysis of Biochemical Oxygen Demand (BOD).

All water samples collected for laboratory analyses will be submitted to Microbac of Marietta, Ohio.

In addition, semi-weekly samples total and dissolved selenium analysis will be collected at the individual effluent side of each biological treatment cell to provide a performance comparison of these units. Each week, one of these semi-weekly sampling events will coincide with the weekly sample collection detailed above. The semi-weekly sampling for total and dissolved selenium is projected for the initial four weeks of the primary test operation period.

After the initial four weeks of operation, sampling frequencies for selenium will be reduced to weekly collection. In addition, if the process conditions and operation are stable at the end of this four week period, a reduced parameter list will be considered as part of this SAP. The decision to invoke a reduced parameter list will be based on the stability of field parameter measurements, and will include the following target parameters (depending on previous sampling results): Se, Cd, Ni, Zn, SO4, Ca, Alkalinity, TDS, and TSS. Prior approval from the appropriate entities will be required before implementation of the target parameter analytical suite.

All samples will be collected using grab sample procedures using laboratory supplied containers. Sample filtering and preservation will be performed in the field using materials that are consistent with QAPP guidelines. Sample designation, storage, and custody procedures are also outlined in the QAPP guidelines.

Selenium speciation of Se^{4+} and Se^{6+} is not anticipated as part of this *Work Plan*.

Water samples will be collected from the pilot treatment system using new clean sample bottle placed under a sampling port installed in the appropriate locations in the system piping. A sample bottle from each sample set, which contains no preservative (i.e., acid), may be used (e.g., the sample bottle for TDS) for collection and transfer of the water to the appropriate sample containers. This sample bottle should be triple rinsed with the water being sampled prior to sample collection at each location. Water samples will be transferred from this bottle to the appropriate sample containers after collection and any required filtering.

Unfiltered Samples: At the frequency discussed above: 1) unfiltered, acidified samples will be collected and analyzed for total selenium and 2) unfiltered and unacidified samples will also be collected for TDS and TSS.

Filtered Samples: Filtered, acidified samples will be collected and analyzed for “dissolved” metals. These samples will be filtered in the field using a new 0.45-micron disposable filter at each sample location. Filtered and unacidified samples will also be collected for major ions (that is, the nutrients).

Parameters to be analyzed for are described below in Section 6.7. Refer to Table 6-1, *Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times* for analyte sample container requirements.

TABLE 6-1
REQUIREMENTS FOR CONTAINERS, PRESERVATION TECHNIQUES, SAMPLE VOLUMES, AND HOLDING TIMES

Sample Container —Water Matrices	Preservative	Parameter*	Method	Sample Preparation Method	Maximum Holding Time (Days)
250 mL HDPE	Field filter; HNO_3 to pH < 2	Dissolved metals	EPA 6010B and 6020A	microwave-assisted acid digestion (3015 ICP-MS) or hot plate acid digestion (3005A ICP) - dissolved (field filtered)	180
250 mL HDPE	HNO_3 to pH < 2	Total selenium and arsenic	EPA 6020A	microwave-assisted acid digestion (3015 ICP-MS) – total (raw)	180
250 mL HDPE	Field filtered; ≤ 6 °C	Sulfate, chloride, fluoride, bicarbonate, nitrate-N	EPA 300.0	dissolved (field filtered)	Nitrate-N , 48 hours; all others, 28 days
250 mL HDPE	Field filtered; ≤ 6 °C	Ammonia-N	EPA 350.1	dissolved (field filtered)	28
250 mL HDPE	Field filtered; HCl or H_2SO_4 to pH < 2; ≤ 6 °C	Total organic carbon	EPA 415	dissolved (field filtered)	28
250 mL HDPE	Field filtered; ≤ 6 °C	Total phosphorus	EPA 365.3	dissolved (field filtered)	2
250 mL HDPE	≤ 6 °C	Total dissolved solids	EPA 160.1	Total (raw)	7
250 mL HDPE	≤ 6 °C	Total suspended solids	EPA 160.2	Total (raw)	7
500 mL HDPE	≤ 6 °C	Biochemical oxygen demand	SM5210B	Total (raw)	48 hours

Notes:
*Refer to Table 6-3, *Water Analytes*, for water parameters and methods.
HDPE – high-density polyethylene

6.3 TREATABILITY TEST WATER FIELD PARAMETER MEASUREMENTS

Measurements of water quality parameters will be made in the field using a decontaminated sample bottle. Field parameter values will be recorded on field data forms and in the field notebooks. Calibrated instruments will be used for field measurements by either placing the instrument probe(s) a plastic sampling container, triple rinsed in the sample water, or where appropriate by placing in directly in the flow. DO and ORP measurements will be made within 30 seconds of sample collection. The following field water quality parameters will be measured:

- pH
- Specific conductivity
- Temperature
- Dissolved oxygen
- ORP

Field meters will be used in accordance with the manufacturer's instructions and calibration in accordance with Table 6-2, *Calibration and Maintenance Requirements for Field Equipment*. For each sampling event, conductivity and pH meter performance will be checked against a reference standard and calibrated as necessary.

TABLE 6-2
CALIBRATION AND MAINTENANCE REQUIREMENTS FOR FIELD EQUIPMENT*

Field Parameter	Required Procedure	Minimum Frequency	Required Equipment or Calibration Fluids
pH	2-point calibration	Each week prior to sampling	Two pH buffers (pH 4, 7), Reference Standard
Temperature	N/A	N/A	N/A
Dissolved Oxygen	1-point reference	Each day prior to sampling	Reference Standard
ORP	1-point reference	Each week prior to sampling	Reference Standard

Notes:
*In the event of a discrepancy, the manufacturer's instruction manual shall take precedence.

6.4 WATER FLOW MEASUREMENTS

Treatment system flow measurement will be conducted at both influent and effluent locations. These measurements will be conducted by calibrated in-line (in-pipe), battery-powered, flow sensing and indicating equipment (for higher flows) or by a timed volumetric method (for lower flows).

Calibration of the flow sensing equipment will consist of a timed volume measurement conducted at initial startup. Periodic cleaning of the flow element also will be conducted followed by a re-calibration as necessary. Periodic cleaning of flow elements will help ensure accurate flow measurements after an initial calibration.

6.5 SAMPLE DESIGNATION

Water samples will be labeled with all necessary information on laboratory supplied labels using waterproof ink. At a minimum, each sample label shall contain the following information:

- Station identification
- Sample identification
- Date and time of sample collection, with sampler's initials
- Analyses required
- Filtered or unfiltered
- Method of preservation, if used
- Sample matrix

Each sample shall be assigned a unique identification number. This number shall be coded according to sample location according to the following format:

MYYaaa-TT1-b-DDMMMYY

where:

- **M -** for Mine Site
  - o B - Ballard
  - o E - Enoch Valley
  - o H - Henry

- **YY -** denotes the station type
  - o IF for influent
  - o EF for effluent.

- **aaa -** denotes the specific pilot test unit station number/location.
  - o CLN - cleanout
  - o CDT - carbon dosing tank
  - o SMF - sand media filter
  - o BC1 - biological treatment cell 1
  - o BC2 - biological treatment cell 2
  - o BC3 - biological treatment cell 3

- **TT -** denotes that sample is for treatability testing (assuming there may be other systems in the future).
  - o TT1 – test treatment system 1

  b - denotes whether the sample involved special field handling or is to be handled in a specific manner; handling codes are as follows:
  - o F - Filtered
  - o U - Unfiltered

As an example, sample number **BIFBC1-TT1-F** describes a non-replicated, filtered water sample collected at influent to biological treatment cell 1.

6.6 SAMPLE HANDLING AND SHIPPING

Sample containers will be sealed in plastic bags with wire ties and immediately placed on ice in an insulated cooler to ≤ 6 °C. Hard body insulated coolers will be provided by Microbac or purchased locally. All samples will be stored in the coolers and handled as specified in Section 2.0 of the *Final QAPP Addendum* (MWH, 2009b). All samples will remain in the coolers until the end of the day when all of the samples will be transferred to a shipping cooler for overnight transport to the analytical laboratory.

Samples will be shipped to Microbac with bagged wet ice in coolers secured with packing tape, via overnight Federal Express service to Microbac. P4 will fill out appropriate chain-of-custody forms; the chain-of-custody will be included with the sample shipment, and copies of all chains-of-custody along with Federal Express waybills will be kept by P4 field personnel.

All samples will be sent to Microbac at the following address:

Microbac
158 Starlite Drive
Marietta, OH 45750
(740) 373-4071
attn: Kathy Albertson

Supplies including sample containers and coolers will be sent to the Monsanto Plant:

Monsanto Company
1853 HWY 34
Soda Springs, ID 83276
(208) 547-1439
attn: Paul Stenhouse

6.7 SAMPLE ANALYSIS

Samples will be analyzed for the water parameters presented in Table 6-3, *Treatability Test Water Analytes,* and as summarized as Attachment A. Microbac of Marietta, Ohio will analyze for all parameters listed.

TABLE 6-3
TREATABILITY TEST WATER ANALYTES

Parameter	Basis	Method	RL	MDL	Reporting Units	Holding Times (days)
aluminum	dissolved	6010B	0.100	0.050	mg/L	180
alkalinity, bicarbonate	dissolved	310.2	10	5	mg/L	28
ammonia-N	dissolved	350.1	0.100	0.050	mg/L	28
arsenic	dissolved and total recoverable	6020A	0.0500	0.0125	mg/L	180
cadmium	dissolved	6020A	0.000500	0.000125	mg/L	180
calcium	dissolved	6010B	0.200	0.100	mg/L	180
chloride	dissolved	300.0	0.200	0.100	mg/L	28
copper	dissolved	6020A	0.002	0.0005	mg/L	180
biochemical oxygen demand	total	SM5210B	3	1	mg/L	2
fluoride	dissolved	300.0	0.2	0.1	mg/L	28
iron	dissolved	6010B	0.100	0.0250	mg/L	180
magnesium	dissolved	6010B	0.500	0.250	mg/L	180
manganese	dissolved	6020A	0.002	0.0005	mg/L	180
nickel	dissolved	6020A	0.004	0.001	mg/L	180
nitrate-N	dissolved	300.0	0.600	0.100	mg/L	2
total-P	dissolved	365.3	0.050	0.0.25	mg/L	2
potassium	dissolved	6010B	1.0	0.25	mg/L	180
selenium	total recoverable	6020A	0.0010	0.0005	mg/L	180
selenium	dissolved	6020A	0.0010	0.0005	mg/L	180
sodium	dissolved	6010B			mg/L	180
sulfate	dissolved	300.0	1.00	0.500	mg/L	28
total dissolved solids	total	160.1	20.0	10.0	mg/L	7
total organic carbon	dissolved	415.1	1	0.500	mg/L	28
total suspended solids	total	160.2	5.0	2.5	mg/L	7
vanadium	dissolved	6010B	0.0100	0.0050	mg/L	180
zinc	dissolved	6020A	0.025	0.005	mg/L	180

Notes:
Method—Method to be utilized by Microbac.
RL—Reporting Limit of Microbac.

6.8 SAMPLING QUALITY ASSURANCE

The following quality control procedures will be followed during pilot system influent and effluent water sampling:

- One blind field duplicate will be collected during each week of field sampling or for approximately 10% of the total sample number (i.e., from 1:12 samples at the beginning of the testing to 1:8 samples at the end of the testing cycle).

- Field teams will collect an additional set of samples at an individual location for matrix spiking and analysis by Microbac. This will be denoted on the chain-of-custody forms. Matrix spike samples will be collected at a minimum rate of once per week.

- Influent and effluent samples are grab samples collected directly from the system influent and effluent sampling spigots to the sample containers. Since there is no sampling equipment, there is no need to decontaminate, thus, no need for equipment rinsate blanks or source water blanks. Because samples will be filtered, one filter blank sample will be collected for each filtered parameter per vendor lot of filters will be collected.

Refer to the *Final QAPP Addendum* (MWH, 2009b) for further details regarding surface water sampling QA/QC procedures.

7.0 REPORTING AND DOCUMENTATION

The water quality data and field observations collected as part of this *Work Plan* will be used to evaluate if the testing objectives are met as listed in Section 2. In addition, the data will support potential modifications to the test system that could be implemented between the two planned test seasons in 2010 and 2011.

Field data and laboratory reports, including all quality control and quality assurance measurements, will be documented in an interim and final report. The interim report will be prepared in the fall 2010 to document and evaluate the test results from the initial season of testing. A final report will be prepared in the fall 2011 that documents all work and data collected in 2010 and 2011.

Since the test work will be performed over the course of two years, weekly and monthly progress reports will not be prepared. However, when test milestones (construction completion, initial startup, seasonal shut down) are reached, the appropriate A/T representatives will be notified.

At a minimum, the interim and final test reports will provide an analysis of the performance characteristics of the treatment process as they pertain to the design and implementation of a permanent application.

8.0 EVALUATION AND RECOMMENDATION

The principal objectives of the *Work Plan* are focused on determining the feasibility of the proposed technology for removal of selenium in seepage water collected from the MWD082 location. A concurrent objective is to use the information that is generated to develop design and implementation criteria for application at different scales and for longer time periods.

In addition to providing data operational documentation, the interim and final test reports will provide an analysis of the performance characteristics of the treatment process as they pertain to the design and implementation of a permanent application. Data quality objectives will be assessed and an evaluation of the test objectives will be conducted. Recommendations based on an evaluation of water quality data and test process operational characteristic will be developed to assist in assessing implementation requirements for other locations and conditions. The information from this test will be used in the FS report that will be prepared for the Ballard Mine, in addition to the FS reports that will be prepared for Henry and Enoch Valley mines.

9.0 PROJECT ROLES AND RESPONSIBILITIES

The performance of the treatability test plan presented herein will involve a teaming effort between P4 personnel (owner/operator) and MWH (technical consultant/contractor). The majority of the site work will be conducted by P4 with oversight and guidance provided by MWH. A breakdown of roles and responsibilities is as follows:

P4 Production

- Procuring test system materials
- Constructing test system, including excavation, tank placement, piping installation, and tank media preparation
- Performing initial startup of recirculation and growth period, including field parameter monitoring
- Conducting system primary operation period, including test system sample collection and handling
- Contracting laboratory analyses
- Performing shutdown and test system modification after first season of operation
- Submitting interim report and final report to appropriate agency representatives
- Decommissioning test system after final testing is completed

MWH

- Specifying materials and preparing detailed test system design
- Providing construction oversight during test system installation
- Providing operational technical support during initial startup and primary test periods
- Preparing the interim report and final report
- Data validation and database management

In addition, necessary approvals and regulatory guidance will be provided by appropriate agency representatives in conjunction with P4 legal counsel. Final handling and disposal of treatment test unit media will be provided by P4 in a manner consistent with the toxicity characteristics of the materials that are removed from the test system.

All on-site and field activities, including field system installation and monitoring, will be performed in accordance with P4's health and safety requirements, including site specific training, and MWH's Health and Safety Plan (MWH, 2009c).

The following schedule assumes approval of this *Work Plan* in April 2010:

April 1 – 16, 2010	Detailed design and material specification
April 16 – 23, 2010	Material procurement and pre-construction (seep collection unit)
April 23 – 30, 2010	System construction
April 30 – May 10, 2010	Startup, recirculation and growth period
May 11 – July 2010	Primary test operation
August 2010	Shutdown and test system modifications

September 2010	Prepare and submit interim report
May – July 2011	Second season testing
August 2011	Prepare and submit final report

10.0 REFERENCES

AMEC Geomatrix, 2008. *Preliminary Draft Treatability Studies Summary Report, Horseshoe Overburden Area, South Rasmussen Mine.* Prepared for P4 Production. December 2008.

MWH, 2004. *Program Quality Assurance Plan, Sampling and Analysis Plan for the Comprehensive Site Investigation for the Southeast Idaho Mine-Specific Selenium Program*. Prepared for P4 Production. April 2004.

MWH 2009a. *2007 and 2008 Data Summary Report*. Prepared by MWH for P4 Production, August 2009.

MWH, 2009b. *Quality Assurance Project Plan Addendum Program Quality Assurance Plan - Final*. Prepared for P4 Production. May 2009.

MWH, 2009c. *Health and Safety Plan – Mines Site Investigation – Draft.* Prepared for P4 Production. April 2009.

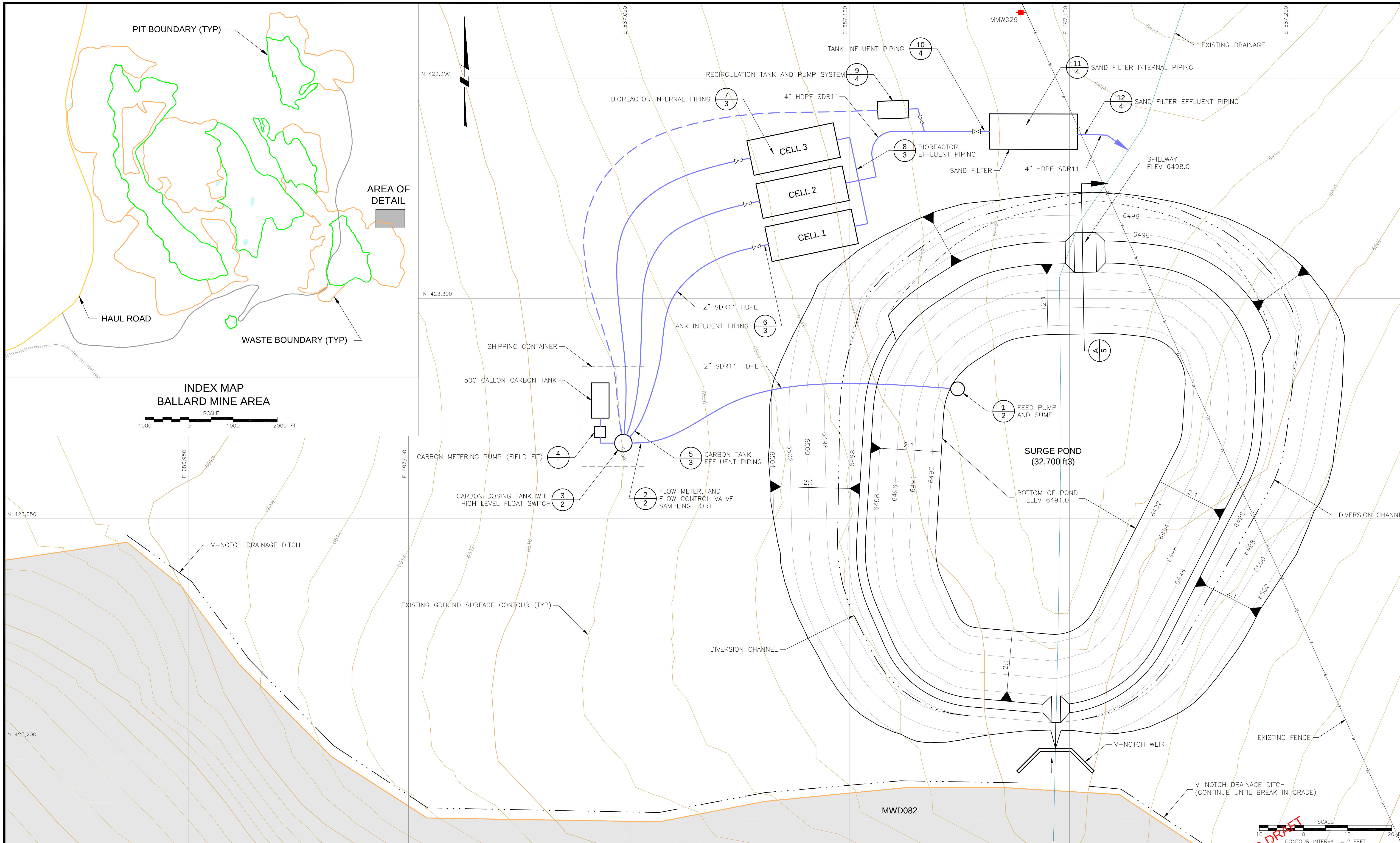
United States Environmental Protection Agency (USEPA), 1998, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. October 1988, EPA/540/G-89/004.

USEPA, 2001. *Selenium Treatment/Removal Alternatives Demonstration Project. Mine Waste Technology Program Activity III, Project 20*. Publication EPA/600/R-01/077. June 2001.

USEPA, 2002. *Guidance for Quality Assurance Project Plans EPA QA/G-5*, December 2002, EPA/240/R-02/009.

USEPA, 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA QA/G-4). EPA/240/B-06/001, February 2006.

FIGURES



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DRAWING REFERENCE(S):
1. POST–MINE TOPOGRAPHY GENERATED FROM:
   - USGS DIGITAL ELEVATION MODELS (DEM)–24K.
   - SURVEY DATA FOR BALLARD MINE PROVIDED BY OLYMPUS AERIAL SURVEYS, INC. DATED: JUNE 2005.
   - SURVEY DATA FOR HENRY MINE AREA PROVIDED BY OLYMPUS AERIAL SURVEYS, INC. DATED: NOVEMBER 2008.
   - SURVEY DATA FOR ENOCH VALLEY MINE AREA PROVIDED BY P4 PRODUCTION DATED: DECEMBER 2007.

PROJECTION: STATE PLANE COORDINATE SYSTEM
ZONE: IDAHO EAST
DATUM: NAD27
VERTICAL DATUM: NAVD29
UNITS: U.S. FEET

DESIGNED BY	D DUPON	07–10
DRAWN BY	D MIRANDA	07–10
CHECKED BY	C TOMLINSON	07–10
APPROVED BY		07–10
PROJECT MANAGER		07–10
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

P4 PRODUCTION
RI / FS FIELD ACTIVITIES

PROJECT LOCATION: BALLARD MINE AREA
PROJECT: TREATABILITY PILOT TEST
TITLE: WASTE ROCK DUMP 082 SYSTEM

MWH

FIGURE: 1 of 5
REVISION: C
FILE NAME: 100793D001

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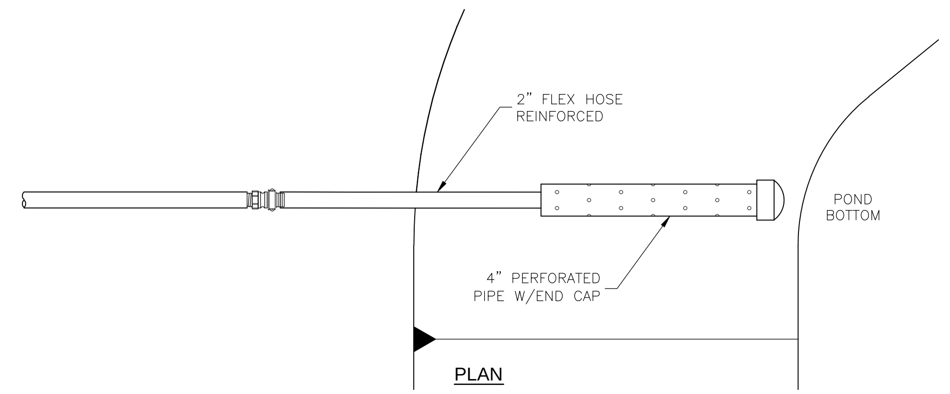
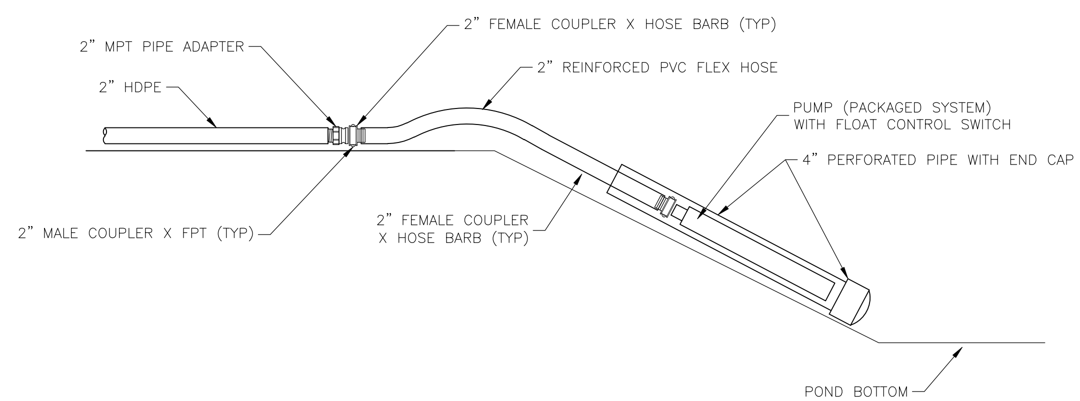


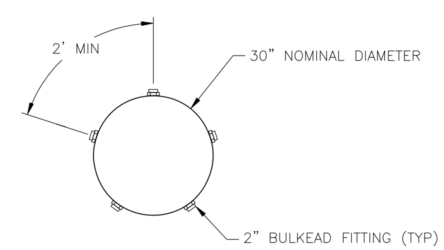
PLAN



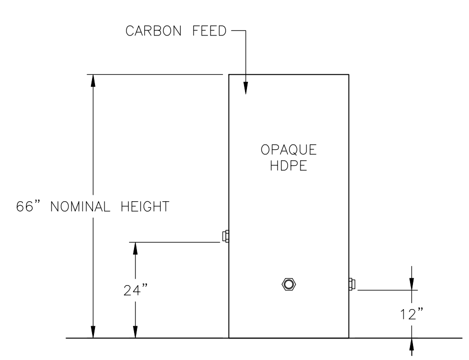
PROFILE

1/1 FEED PUMP AND SUMP

SCALE 1 0 1 2 FEET



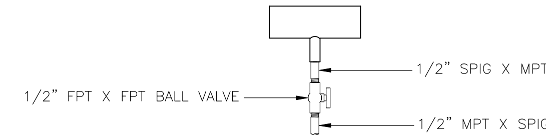
PLAN



ELEVATION

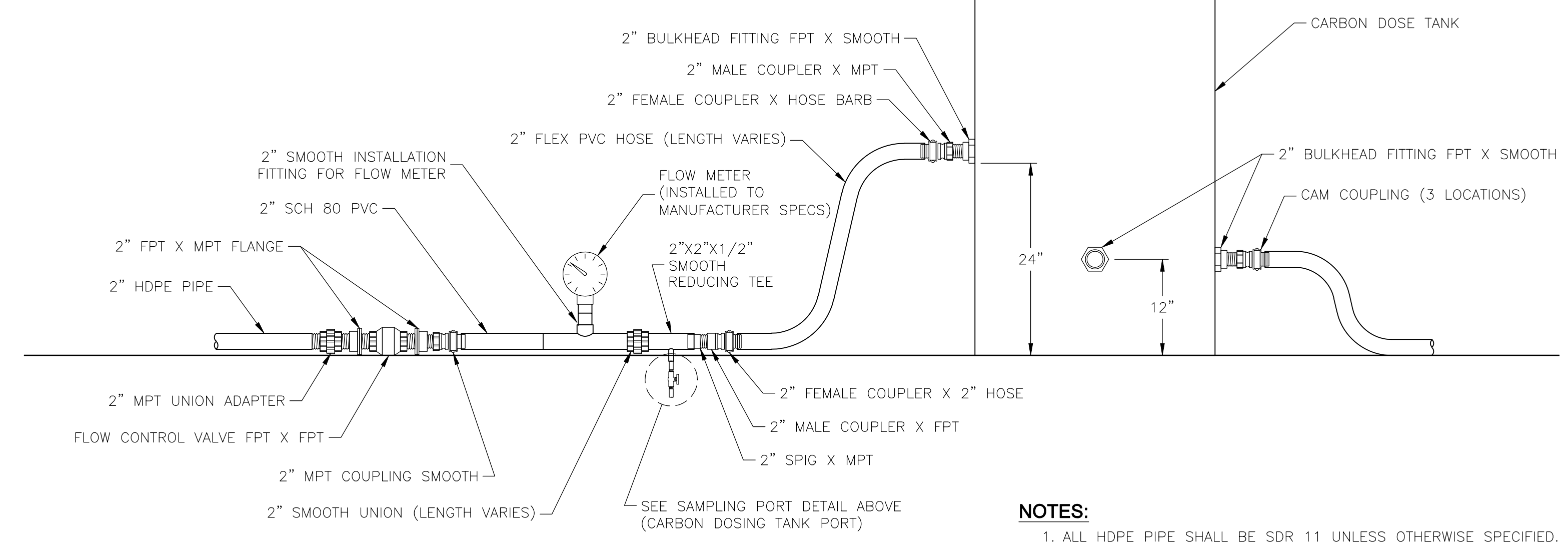
3/1 CARBON DOSE TANK

SCALE 2 0 2 4 FEET



SAMPLING PORT DETAIL

NOT TO SCALE



ELEVATION

2/1 FLOW METER AND SAMPLING PORT

SCALE 1 0 1 2 FEET

NOTES:

1. ALL HDPE PIPE SHALL BE SDR 11 UNLESS OTHERWISE SPECIFIED.
2. ALL PVC PIPE SHALL BE SCH 40 UNLESS OTHERWISE SPECIFIED.
3. SAND GRADATION SHALL BE THE FOLLOWING:

U.S. SIEVE NUMBER	PERCENT PASSING
4	95–100
8	70–100
16	40–90
30	25–70
50	2–25
100	<4
200	<2

4. GRAVEL SHALL HAVE THE FOLLOWING GRADATION:

U.S. SIEVE NUMBER	PERCENT PASSING
1–1/2"	100
1"	100–90
3/4"	40–85
1/2"	25–60
#4	0–10

EQUIPMENT LIST:

Item	Quantity	Description
Tanks		
Reactor and Sand Filter Tanks	4	Jensen JZ-400 weirless tank, or equivalent
Carbon Tank	1	500 gal LDPE vertical tank. Snyder or equivalent
Recirculation tank	1	500 gal HDPE horizontal tank SG 1.5, or equivalent
carbon dosing tank	1	500 gal HDPE horizontal tank SG 1.5, or equivalent
Piping		
2-inch HDPE Pipe	1000 feet	Standard SDR 11 HDPE pipe
4-inch HDPE Pipe	250 feet	Standard SDR 11 HDPE pipe
2-inch PVC FlexPipe	100 feet	BraidFLEX 70 N Braid-reinforced PVC Tubing. Part number 8470-2790
2-inch PVC		Schedule 80
4-inch perforated PVC pipe	50 feet	3,000-lb crush strength, or equivalent
4-inch straight PVC pipe	50 feet	Schedule 40
8-inch perforated PVC pipe	50 feet	Schedule 40
8-inch straight PVC pipe	50 feet	Schedule 40
Fittings		
2-inch FPT by smooth bulk head fitting	7	Part Number BFA1020CES
2-inch FPT by FPT bulk head fitting	6	Part Number BFA1020TES
2-inch Female Coupler by Hose Barb	22	Part Number 200C
2-inch Male Coupler by FPT	1	Part Number 200A
2-inch Male Coupler by MPT	21	Part Number 200F
2-inch Spig x MPT	7	Part Number 861-015
2-inch FPT flange	4	Part Number 852-020
2-inch smooth installation fitting	1	Part Number PV8S020
2-inch SPIG x MPT	1	Part Number 861-020
2"x4" reducer	10	Part Number 829-421
2-inch female pipe adapter	8	Weld on to HDPE pipe with standard FPT thread
2"x2"x0.5" reducing tee	1	Part Number 801-247

Item	Quantity	Description
4-inch FPT Tee	1	Part Number 805-040
4-inch MPT pipe adapter	4	Weld on to HDPE pipe with standard MPT thread
4-inch cross	1	Part Number 820-040
4-inch flange HDPE pipe adapter	1	Flange will be welded onto HDPE pipe.
4-inch MPT/FPT flange	4	Part Number 852-040
4-inch male coupler by MPT	4	Part Number 400F
4-inch female coupler by hose	4	Part Number 400C
4 inch SPIG flange	1	Part Number 856-040
4-inch FPTxFPT bulk head fittings	1	Part Number BFA1040TES
4-inch FPTx Smooth bulk head fittings	1	Part Number BFA1040CES
Pumps		
System Feed Pump	1	PS600-C-SJ8-5/ECDRIVE 600C, Lorentz Centrifugal Submersible Pump System, or equivalent
Recirculation Pump	1	Dayton DCM100 Sump Pump, or equal
Carbon Feed Pump	1	Packaged Diaphragm Metering Pump, Solar Powered, Cole-Parmer Part No. EW-73803-03, or equivalent
Valves		
2-inch PVC ball valve	5	Asahi. Part Number 1601020, Type 21
4-inch ball valve	1	Spears 200 Standard Ball Valve. Part Number 3621-040
Flow Meters		
Paddle Wheel Flow Meter	4	Signet Series 2537, or equivalent

Notes:
1) All part numbers referenced are from Harrington Plastics. Installer may use equivalent part from other manufacturer.
2) Quantities are approximated. Subject to change based on field conditions.
3) All PVC fittings are Schedule 80

NOTE:

1. INSTALL EQUIPMENT IN ACCORDANCE WITH MANUFACTURER SPECIFICATIONS.

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A	ISSUED FOR CLIENT REVIEW	DM	CT	05–10

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DRAWN BY	D MIRANDA	07–10
CHECKED BY	C TOMLINSON	07–10
APPROVED BY		07–10
PROJECT MANAGER		07–10
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CLIENT REFERENCE NO.		

P4 PRODUCTION
RI / FS FIELD ACTIVITIES

PROJECT LOCATION: BALLARD MINE AREA

REVISED DRAFT

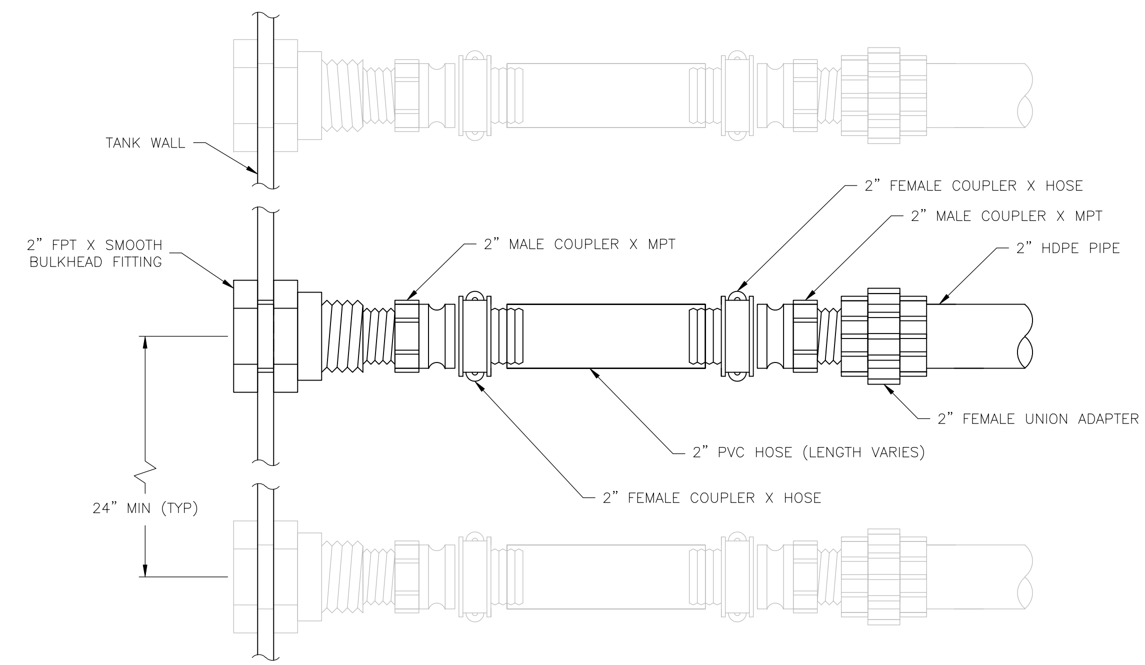
PROJECT: TREATABILITY PILOT TEST

TITLE: CONSTRUCTION DETAILS

MWH

FIGURE: 2 of 5 | REVISION: C

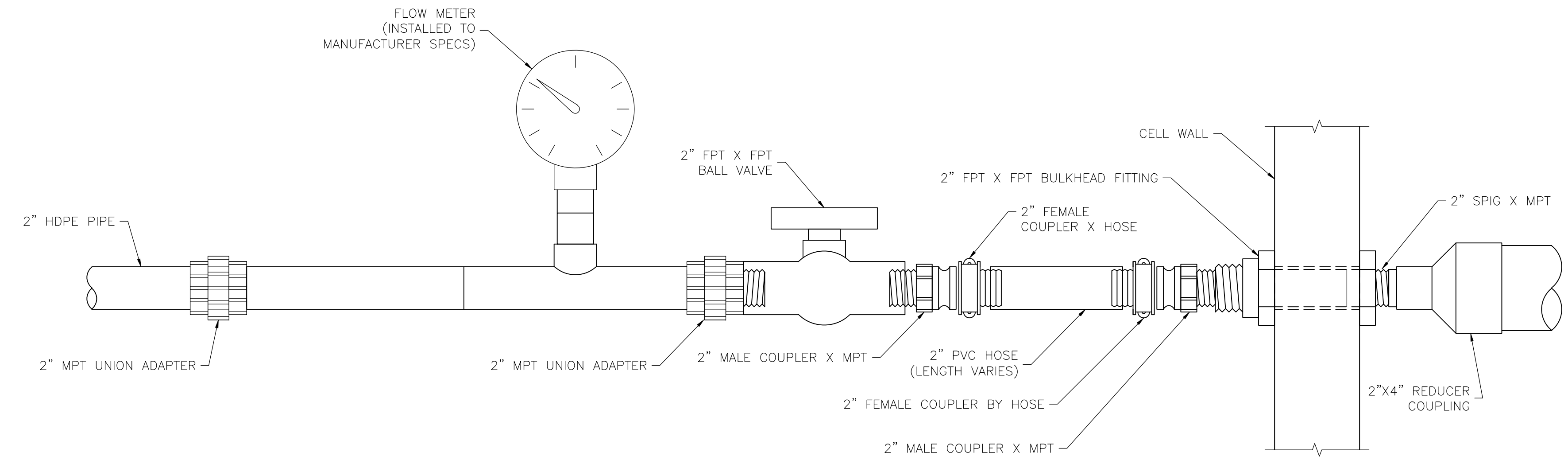
FILE NAME: 100793D002



PLAN

5/1 CARBON DOSING TANK EFFLUENT PIPING

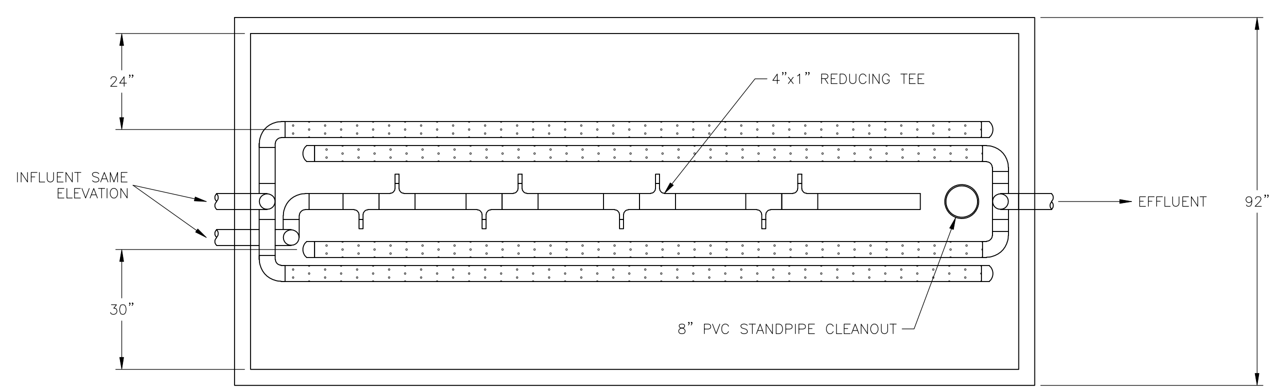
SCALE 3 0 3 6 INCHES



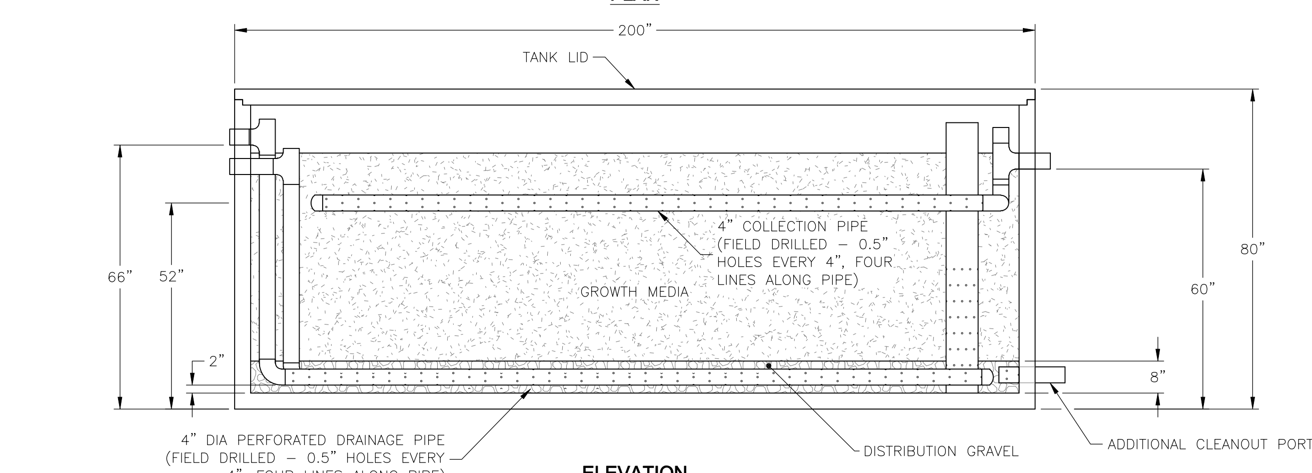
ELEVATION

6/1 BIOREACTOR CELL INFLUENT PIPING

SCALE 4 0 4 8 INCHES



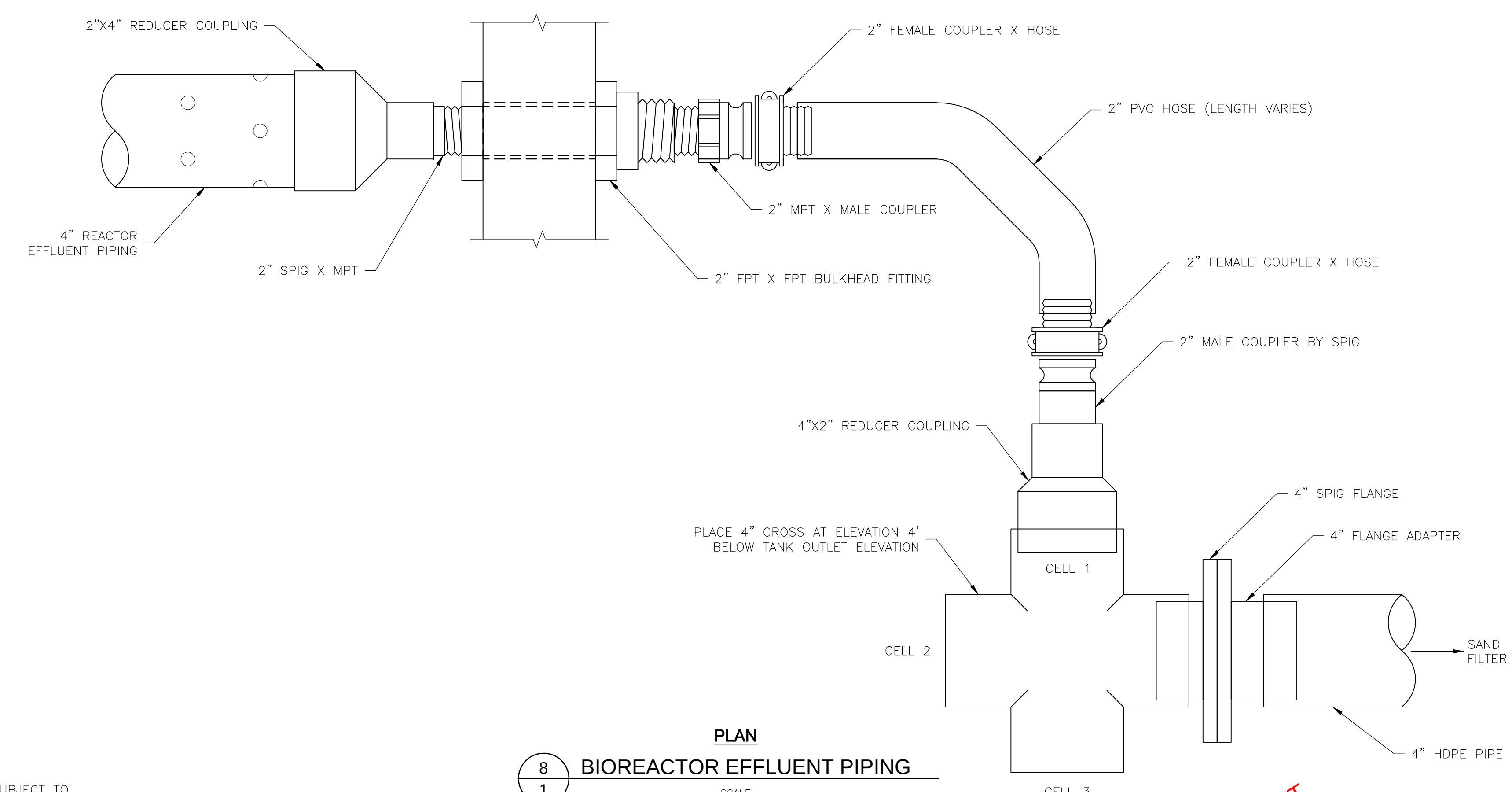
PLAN



ELEVATION

7/1 BIOREACTOR INTERNAL PIPING

SCALE 2 0 2 FEET



PLAN

8/1 BIOREACTOR EFFLUENT PIPING

SCALE 3 0 3 6 INCHES

NOTES:

1. ALL DIMENSIONS ARE TYPICAL, SUBJECT TO FIELD MODIFICATION.
2. REACTOR CELLS SHALL BE FITTED WITH VENTS.

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CLIENT REFERENCE NO.		

P4 PRODUCTION
RI / FS FIELD ACTIVITIES

PROJECT LOCATION: BALLARD MINE AREA

REVISED DRAFT

PROJECT: TREATABILITY PILOT TEST

TITLE: CONSTRUCTION DETAILS

MWH

FIGURE: 3 of 5
REVISION: C
FILE NAME: 100793D004

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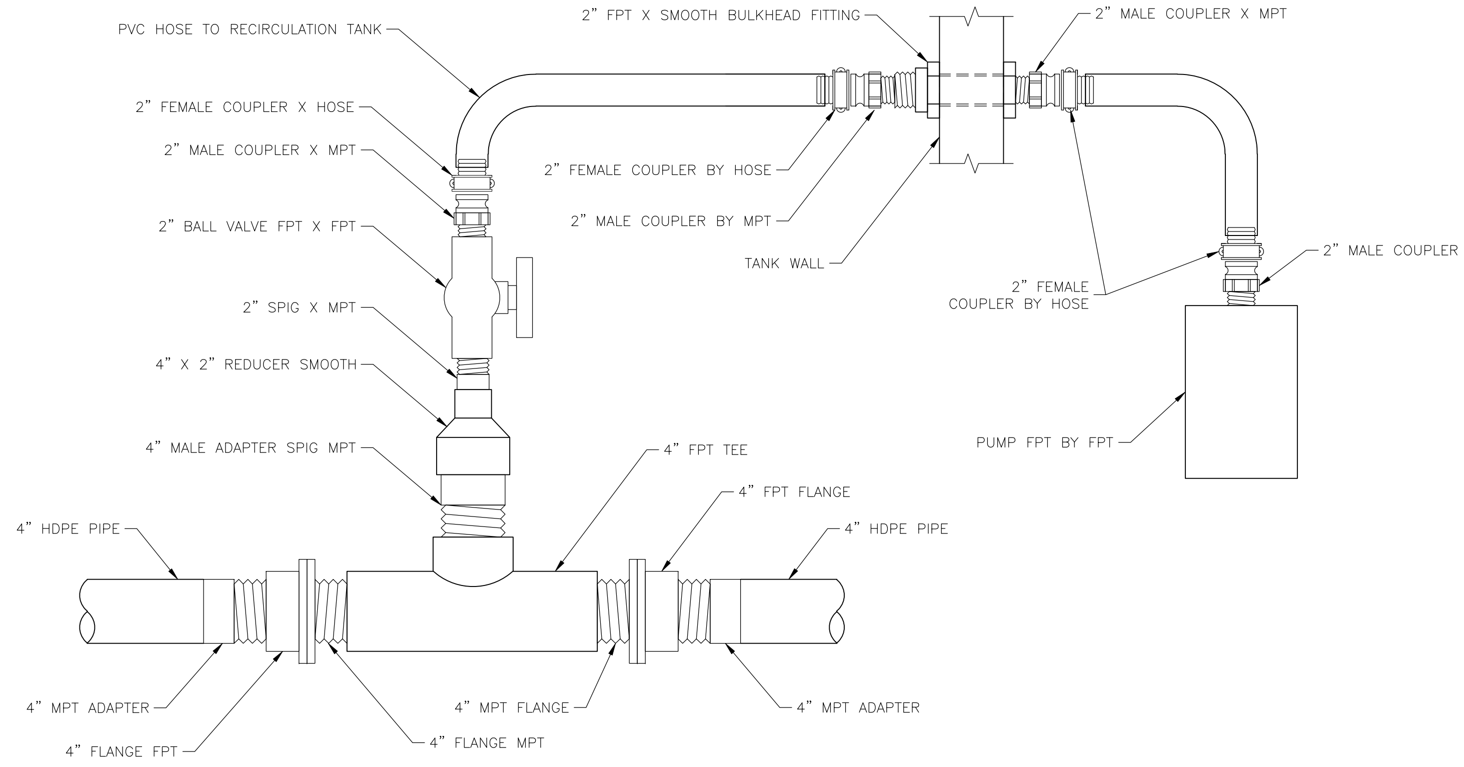
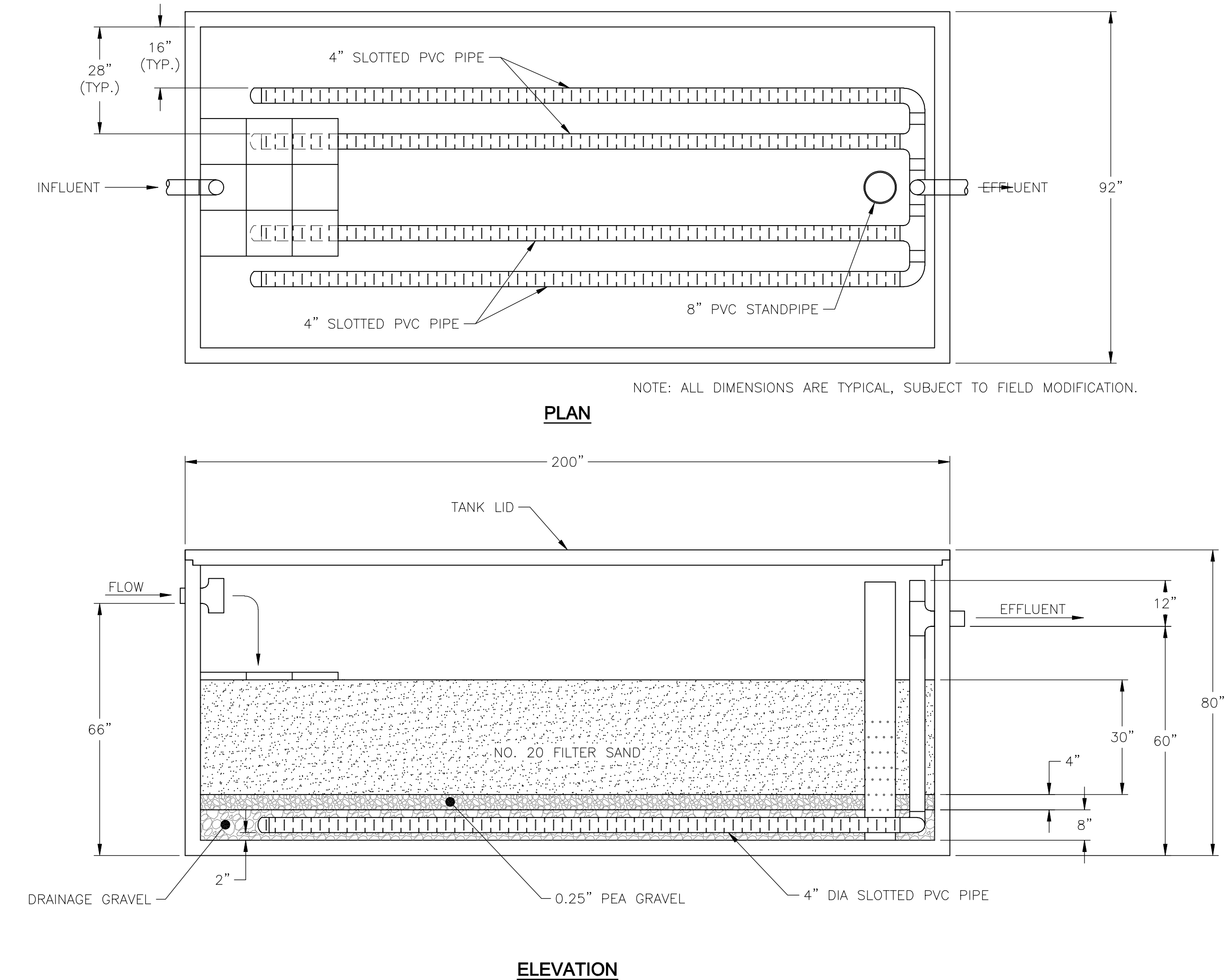


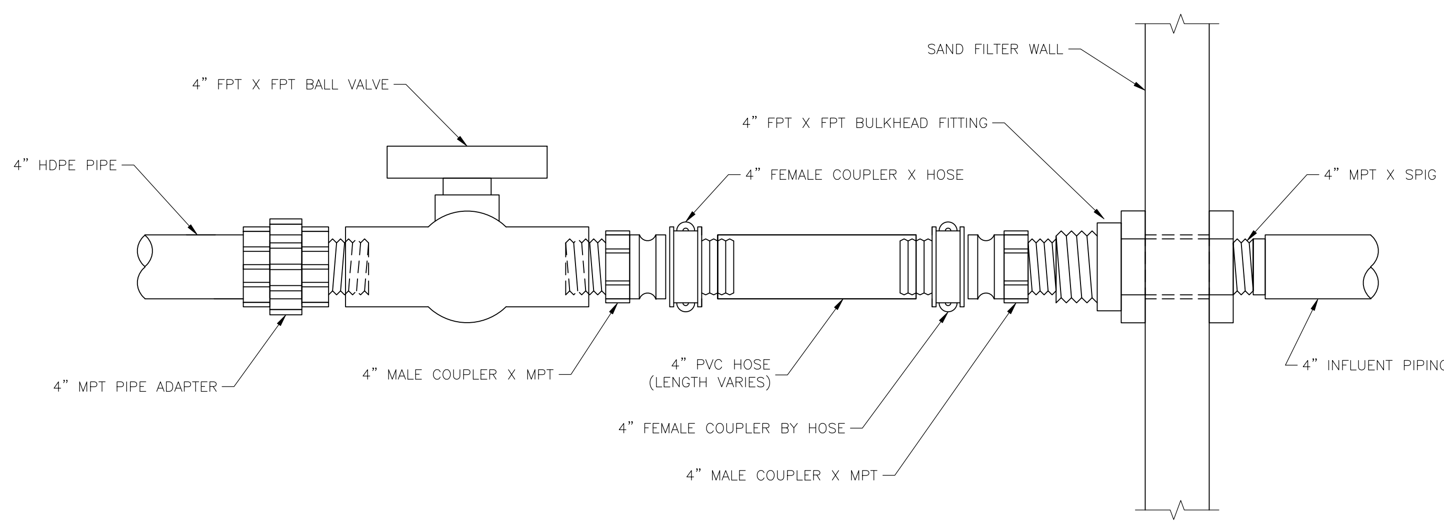
9
1
RECIRCULATION TANK AND PUMP SYSTEM

SCALE 6 0 6 12 IN



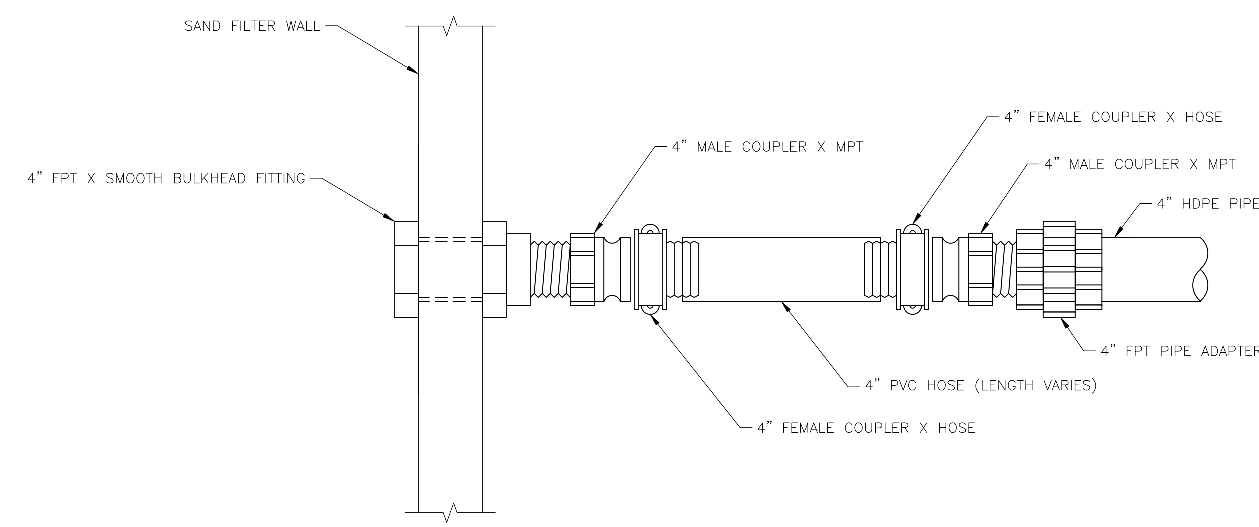
11
1
SAND FILTER INTERNAL PIPING

SCALE 2 0 2 2 FT



10
1
SAND FILTER INFLUENT PIPING

SCALE 6 0 6 12 IN



12
1
SAND FILTER EFFLUENT PIPING

SCALE 6 0 6 12 IN

REVISED DRAFT

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APPROVED BY		07–10
PROJECT MANAGER		07–10
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

P4 PRODUCTION
RI / FS FIELD ACTIVITIES

PROJECT LOCATION: BALLARD MINE AREA
PROJECT: TREATABILITY PILOT TEST
TITLE: CONSTRUCTION DETAILS

MWH

FIGURE: 4 of 5
REVISION: C
FILE NAME: 100793D005

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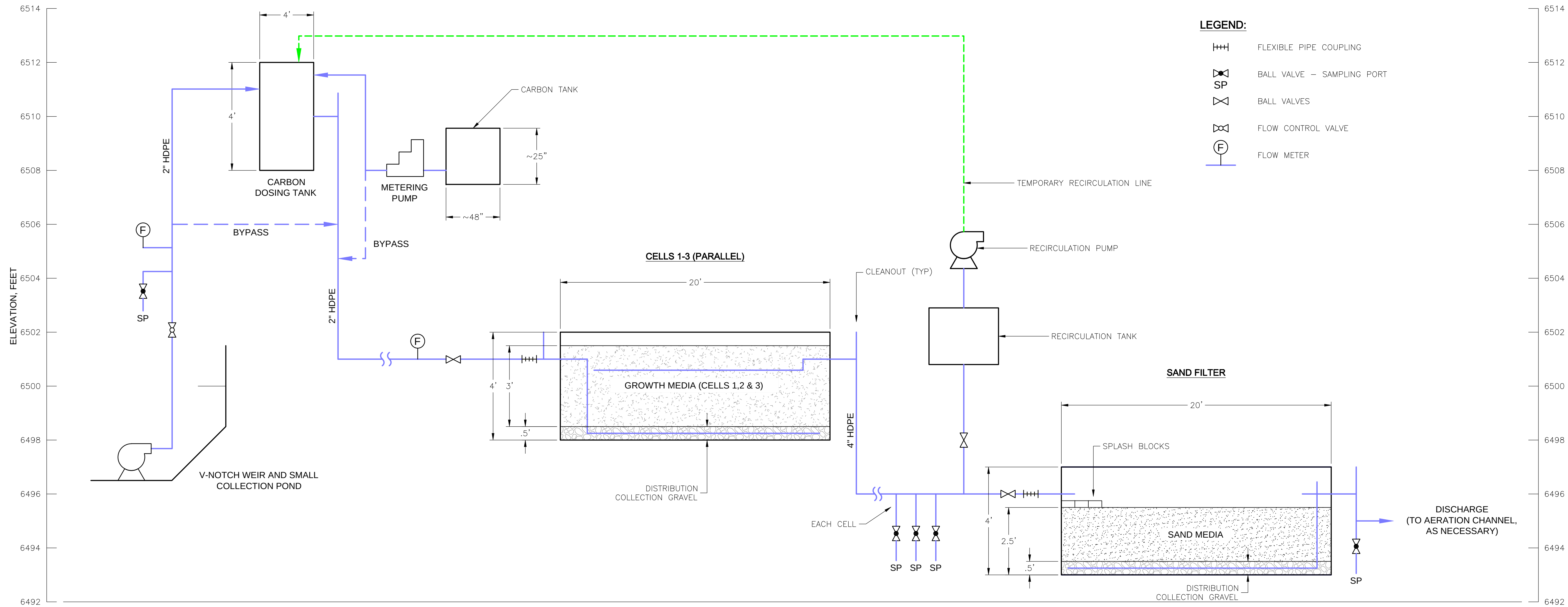
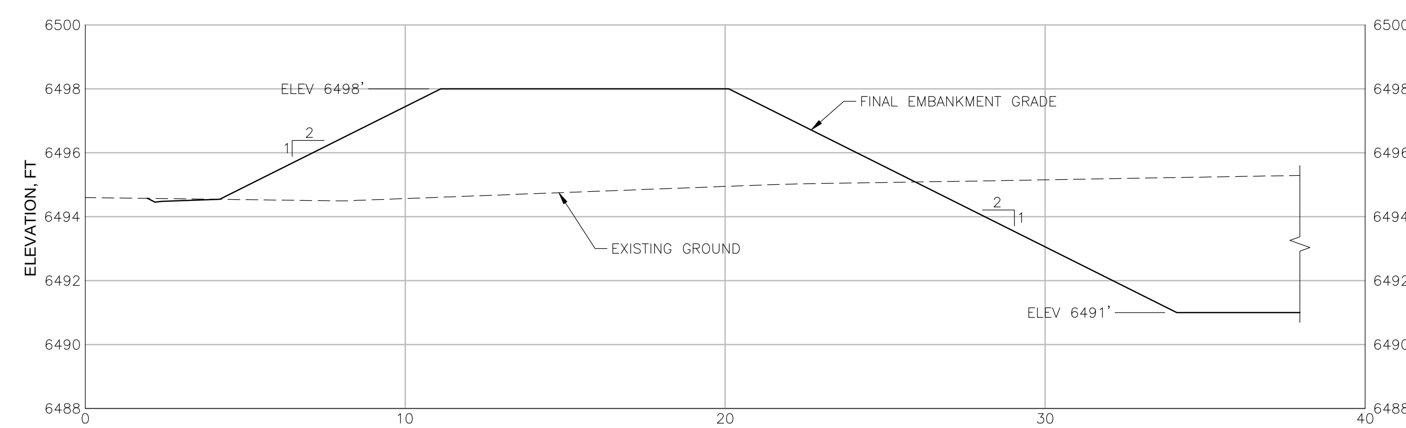


TEST PROCESS

VERTICAL SCALE 2 0 2 FEET
HORIZONTAL SCALE 4 0 4 FEET
VERTICAL EXAGGERATION = 2X



A 1 SECTION THROUGH EMBANKMENT

SCALE 3 0 3 6 FEET
CONTOUR INTERVAL = 2 FEET

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P4 PRODUCTION
RI / FS FIELD ACTIVITIES

PROJECT LOCATION: BALLARD MINE AREA

REVISED DRAFT

PROJECT: TREATABILITY PILOT TEST

TITLE: TEST PROCESS PROFILE

MWH

FIGURE: 5 of 5
REVISION: C
FILE NAME: 100793D003

ATTACHMENT A

ATTACHMENT A
SUMMARY OF SAMPLES TO BE COLLECTED AND TESTING PARAMETERS
(Page 1 of 2)

					Analytical Parameter											
					Field	Laboratory (Method)										
Sample Identification	Sample Location	Sampling Period or Frequency	Sample Type	Basis	pH, temp., SC, DO, ORP	Ca,Mg,K,Na (6010B)	As,Cd,Ni,Se,Zn (6020A)	Se,As (6020A)	SO4,Cl,F,NO3-N (300.0)	Alkalinity HCO3 (310.2)	Ammonia-N (350.1)	Total P (365.4)	TOC (415.1)	TDS (160.1)	TSS (160.2)	BOD (SM5210B)
Initial Test Recirculation and Growth Period																
BEF-RPF-T1-R1B-U	Recirc Pump Feed	1st Cycle	Effluent	Unfiltered	X											
BEF-RPF-T1-R1E-U	Recirc Pump Feed	1st Cycle	Effluent	Unfiltered	X											
BEF-RPF-T1-R2B-U	Recirc Pump Feed	2nd Cycle	Effluent	Unfiltered	X											
BEF-RPF-T1-R2E-U	Recirc Pump Feed	2nd Cycle	Effluent	Unfiltered	X											
BEF-RPF-T1-R3B-U	Recirc Pump Feed	3rd Cycle	Effluent	Unfiltered	X											
BEF-RPF-T1-R3E-U	Recirc Pump Feed	3rd Cycle	Effluent	Unfiltered	X											
Primary Test Operation - Weeks 1 through 4																
BIF-CDT-T1-W01-F	Carbon Dosing Tank Port	Weekly	Influent	Filtered		X	X	X	X							
BIF-CDT-T1-W01-U	Carbon Dosing Tank Port	Weekly	Influent	Unfiltered	X			X		X	X	X	X	X	X	X
BEF-CBE-T1-W01-F	Combined Bioreactor Effluent	Weekly	Effluent	Filtered		X	X	X	X							
BEF-CBE-T1-W01-U	Combined Bioreactor Effluent	Weekly	Effluent	Unfiltered	X			X		X	X	X	X	X	X	X
BEF-SMF-T1-W01-F	Sand Media Filter	Weekly	Effluent	Filtered		X	X	X	X							
BEF-SMF-T1-W01-U	Sand Media Filter	Weekly	Effluent	Unfiltered	X			X		X	X	X	X	X	X	X
BEF-BC1-T1-W1A-F	Biological Treatment Cell 1	Semiweekly	Effluent	Filtered				X								
BEF-BC1-T1-W1A-U	Biological Treatment Cell 1	Semiweekly	Effluent	Unfiltered	X			X								
BEF-BC1-T1-W1A-F	Biological Treatment Cell 2	Semiweekly	Effluent	Filtered				X								
BEF-BC1-T1-W1A-U	Biological Treatment Cell 2	Semiweekly	Effluent	Unfiltered	X			X								
BEF-BC1-T1-W1A-F	Biological Treatment Cell 3	Semiweekly	Effluent	Filtered				X								
BEF-BC1-T1-W1A-U	Biological Treatment Cell 3	Semiweekly	Effluent	Unfiltered	X			X								
BEF-BC1-T1-W1B-F	Biological Treatment Cell 1	Semiweekly	Effluent	Filtered				X								
BEF-BC1-T1-W1B-U	Biological Treatment Cell 1	Semiweekly	Effluent	Unfiltered	X			X								
BEF-BC1-T1-W1B-F	Biological Treatment Cell 2	Semiweekly	Effluent	Filtered				X								
BEF-BC1-T1-W1B-U	Biological Treatment Cell 2	Semiweekly	Effluent	Unfiltered	X			X								
BEF-BC1-T1-W1B-F	Biological Treatment Cell 3	Semiweekly	Effluent	Filtered				X								
BEF-BC1-T1-W1B-U	Biological Treatment Cell 3	Semiweekly	Effluent	Unfiltered	X			X								
Primary Test Operation - Weeks 5 through 16																
BIF-CDT-T1-W02-F	Carbon Dosing Tank Port	Weekly	Influent	Filtered		X	X	X	X							
BIF-CDT-T1-W02-U	Carbon Dosing Tank Port	Weekly	Influent	Unfiltered	X			X		X	X	X	X	X	X	X
BEF-CBE-T1-W02-F	Combined Bioreactor Effluent	Weekly	Effluent	Filtered		X	X	X	X							

ATTACHMENT A

SUMMARY OF SAMPLES TO BE COLLECTED AND TESTING PARAMETERS

					Analytical Parameter										
					Field	Laboratory (Method)									
Sample Identification	Sample Location	Sampling Period or Frequency	Sample Type	Basis	pH, temp., SC, DO, ORP	Ca,Mg,K,Na (6010B)	As,Cd,Ni,Se,Zn (6020A)	Se,As (6020A)	SO4,Cl,F,NO3-N (300.0)	Alkalinity HCO3 (310.2)	Ammonia-N (350.1)	Total P (365.4)	TOC (415.1)	TDS (160.1)	TSS (160.2)	BOD (SM5210B)
BEF-CBE-T1-W02-U	Combined Bioreactor Effluent	Weekly	Effluent	Unfiltered	X			X		X	X	X	X	X	X	X
BEF-SMF-T1-W02-F	Sand Media Filter	Weekly	Effluent	Filtered		X	X	X	X							
BEF-SMF-T1-W02-U	Sand Media Filter	Weekly	Effluent	Unfiltered	X			X		X	X	X	X	X	X	X
BEF-BC1-T1-W2A-F	Biological Treatment Cell 1	Weekly	Effluent	Filtered				X								
BEF-BC1-T1-W2A-U	Biological Treatment Cell 1	Weekly	Effluent	Unfiltered	X			X								
BEF-BC1-T1-W2A-F	Biological Treatment Cell 2	Weekly	Effluent	Filtered				X								
BEF-BC1-T1-W2A-U	Biological Treatment Cell 2	Weekly	Effluent	Unfiltered	X			X								
BEF-BC1-T1-W2A-F	Biological Treatment Cell 3	Weekly	Effluent	Filtered				X								
BEF-BC1-T1-W2A-U	Biological Treatment Cell 3	Weekly	Effluent	Unfiltered	X			X								

BOD - Biochemical Oxygen Demand
Ca,Mg,K,Na - calcium, magnesium, potassium, and sodium
Cd,Ni,Se, and Zn - cadmium, nickel, selenium, and zinc
DO - dissolved oxygen
HCO3 - bicarbonate
NO3 - nitrate
ORP - oxidation-reduction potential

P - phosphorus
SC - specific conductivity
SO4 - sulfate
TDS - total dissolved solids
TOC - total organic carbon
TSS - total suspended solids